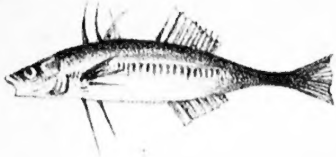

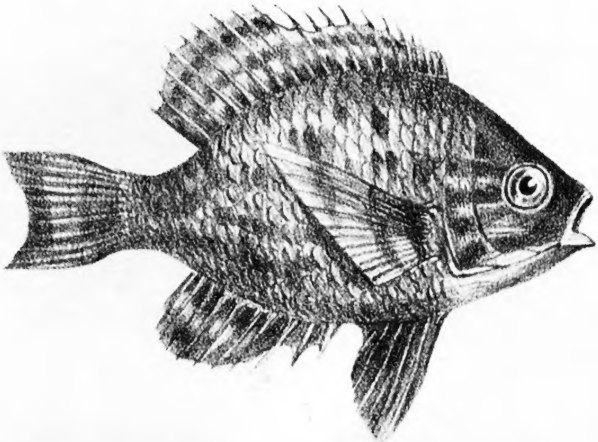

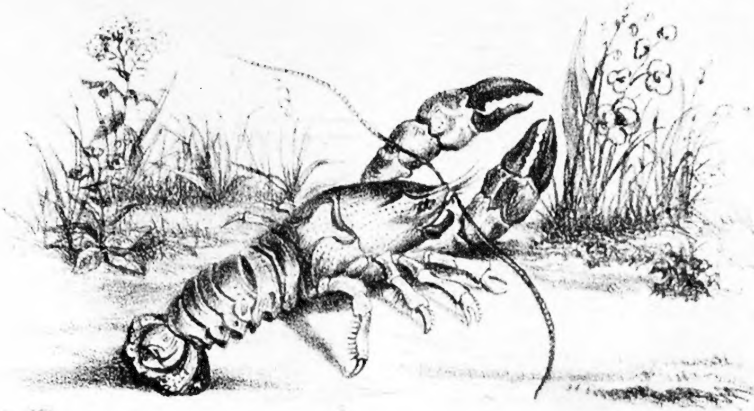

LIFE

BENEATH THE WATERS;

OR,

The Aquarium in America.

ILLUSTRATED BY PLATES AND WOODCUTS DRAWN FROM LIFE.

BY

ARTHUR M. EDWARDS,

MEMBER OF THE NEW YORK LYCEUM OF NATURAL HISTORY.

NEW YORK:
H. BAILLIÈRE, 290 BROADWAY,
AND 219 REGENT STREET, LONDON.
PARIS: J. B. BAILLIÈRE ET FILS, RUE HAUTEFEUILLE.
MADRID: C. BAILLY-BAILLIÈRE, CALLE DEL PRINCIPE.
1858.

W. H. Tinson, Printer and Stereotyper, 43 Centre Street.

TO

CHARLES M. WHEATLEY, ESQ.,

OF NEW YORK,

WHOSE GENEROSITY OF DISPOSITION AND SCIENTIFIC TALENTS ARE WELL KNOWN,

THIS WORK IS DEDICATED,

BY

HIS OBLIGED FRIEND,

THE AUTHOR.

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ERRATA.

Page 70, third line from bottom, for *cyprynis* read *cyprynus*.
" 79, second " " " " *P. exaentus* read *P. exacutus*.
" 109, ninth " " " " *chondrus crispus* read *cystoclomium purpurascens*.
" 116, tenth " " " " *T. tabbacaria* read *F. tabbacaria*.

LIFE BENEATH THE WATERS.

CHAPTER I.

THE PRINCIPLES OF THE AQUARIUM.

The Principles of the Aquarium not a New Discovery—Mr. Warrington, Inventor of the Aquarium—Tanks of the Zoological Society of London—Practice necessary in the Management of Aquaria—Fish-globes—Animals inhale Oxygen and exhale Carbonic Acid Gas—The "Black-hole" of Calcutta—Use of Plants in Nature—Use of Snails in an Aquarium.

THE principles on which the *Aquarium*, or, as some writers have called it, the *Aqua-vivarium*, is founded, are not of recent discovery; on the contrary, they have been known for some time—but it is, undoubtedly, to Mr. Robert Warrington that we owe most of the practical knowledge that is now found to be so useful to amateurs in the management of these beautiful parlor ornaments. Mr. P. H. Gosse has, also, contributed vast quantities of valuable information in his books which amuse, and, at the same time, instruct the reader. These two gentlemen, together with Messrs. Hibberd, Lankester and also a host of minor workers in this field of knowledge, have opened to the student of natu-

ral history an almost boundless and untravelled space, the outskirts of which are the useful and wonderful discoveries that they have given to him during the last four or five years, and which are so fascinating in all their details, that they attract and rivet the attention not only of scientific men, but of those who, until lately, have looked upon the votaries of science as forming a useless class. This revolution has been brought about by the vast strides that science has made during the last twenty years, aided principally by two seemingly insignificant instruments : the MICROSCOPE and the AQUARIUM.

In a lecture given by Mr. Warrington before the Royal Institution of Great Britain, on the 27th of March, 1857, that gentleman gives us a history of the *Aquarium*, with the reasons that led him to think of establishing such a collection, in which the animal and vegetable existences would be so balanced that the water should not need changing. After considerable trouble and persevering study, and several accidents that would have discouraged many men, he succeeded ; and, in a paper read in the month of March, 1850, before the Chemical Society of London, he gave to the world an account of his success. His first experiments were with fresh-water plants and animals, and on the complete success of the tanks containing these, he commenced operations with marine objects. In this branch, he has been more successful than any other naturalist that has given the results of his experience with the *Aquarium* to the public.

It was in the year 1852, that the Zoological Society of London determined to erect a house in their gardens,

in the Regent's Park, extensive enough to hold several large tanks, in which both fresh-water and marine plants and animals might be kept for observation; in the spring of 1853, this house was thrown open to the public; and immediately the subject of the *Aquarium* was rendered popular and observers multiplied immensely. These tanks in the Regent's Park have been mostly stocked by Mr. Gosse, whose experience in the management of the vessels is very great, though his first attempts, as he tells us in his book on "the *Aquarium*," were for the purpose of keeping fish alone alive, so that he might be enabled to study their habits. He soon, however, found that he might obviate the changing of the water every day, by introducing plants—and an *Aquarium* was established.

An *Aquarium* should be constructed on such principles that it will be, to a certain extent, a world in miniature, being self-supporting, self-renovating and, in fact, nature on a small scale removed into our parlor. In order to obtain this perfection of management, some practice is necessary, and though we may fail once or twice in the attainment of our object, let us remember that every slight mishap is to be ascribed to a fault of our own, to some point, however seemingly insignificant, yet essential, which we have failed to take into consideration. Each such failure leads us to a vast amount of useful facts, not to be obtained otherwise, and which it is our own fault if we do not take advantage of. The thing can be done by you as it has been done by others: so "never dispair." It has required and taken years of patient toil

and perseverance to accomplish what has been done in the knowledge required for the proper management of the *Aquarium*, and still it is in its infancy. Perhaps before long we shall have *Aquaria*, in which we may be able to observe the habits of the shark, the whale and, perhaps, the veritable sea-serpent itself, and interest ourselves in watching them secure their prey. And again, we very likely shall have tanks in which the rise and fall of the tide will be imitated so exactly, as to allow us to keep certain animals and plants that it is not possible to make flourish in an *Aquarium* where the water is always at rest. We may have storms in our miniature ocean that may turn out to be but "tempests in a tea-pot," but which will answer all the purpose of their mightier brothers.

Some time back it was the fashion (and is still to a certain extent, but I am glad to see it is rare) to keep gold-fish in globes for our amusement, but unintentionally for their discomfort. It is said that Madame Pompadour, to her other sins and weaknesses, added that of setting this fashion of studying the, really, tortures of poor fish. Whenever I see several gold-fish in a glass globe, I feel inclined either to turn them out into the nearest stream, or to make their life of confinement bearable by throwing into the water some kind of water-plant. Keeping birds in cages is not so cruel as keeping fish in globes, as they are usually so kept; the birds have plenty of food, air and sunshine, but the fish are retained in imprisonment on short commons, deprived of these necessaries to their well-being and comfort. Many persons wonder why they have never been able to raise, or, at least, to keep alive fish

in globes; but such a thing is against all rules of nature, and, therefore, impossible. If we keep gold-fish, or, indeed, any other kind of fish, in a globe of water, they sooner or later die, and if we do not change the water often, that catastrophe will the more speedily occur. But let us procure a handful of any submerged aquatic plant, that is to say, a plant that grows beneath the surface of fresh-water, and, having washed it well, throw it into our fish globe, and we will, if the vessel does not contain too many fish, find we shall not have to change the water for days, nor, perhaps, weeks. It is on this principle of the action that the plants exert in keeping the water fit for the inhabitance of fish, that the *Aquarium* is constructed.

It has been found by experiment that animals take into their lungs the gas, oxygen or vital air as it is also called, one of the components of the atmosphere, and give out this gas, combined with another substance, carbon or charcoal, which is one of the constituents of all organized or living matter, be it animal or vegetable. Now, when carbon (a perfectly harmless substance) is combined with oxygen (a life-giving body), there is formed a very poisonous compound, termed carbonic-acid gas, being the same body that collects in wells, in some of our mines, and which is also given off from stoves, often causing disease and death.

Who does not know the dreadful tale of the sufferings of hundreds of persons, shut up at night in a prison called "the black hole," at Calcutta, to which there were but two openings, the door, that was locked, and a small window, placed near the ceiling? Now, as carbonic-acid gas, which

is considerably heavier than common air, formed in the room, and it did so very quickly from the continuous breathing of this crowd of persons, it settled at the bottom, and filling the room up as if it had been water, drowned the inmates as surely as if it had been that substance. Next morning, when the door was opened, the persons confined were found crowded together as near the window as they could get, and dead and dying in large numbers. So, if we place our fish in water and leave them there, they will, in time, exhale enough carbonic-acid gas to impregnate the water, and, at last, cause their own death. But, let us see how nature has provided for this expediency—for in pond, river, and ocean, the same action must be going on as in our fish-globe. To provide oxygen for the aquatic animals, nature has given plants—those which grow in fresh water resembling, very much, those living on the land, whilst those in the ocean are of a totally different character—a difference which I will explain when we come to speak of the marine *Aquarium*.

Plants inhale carbonic acid, and appropriating the carbon to build up their own tissues, give off the oxygen for the use of animals, so that this gas oxygen becomes but a carrier of carbon from the animal economy to that of the vegetable, and when the sun shines on the plants in our *Aquarium*, very often their leaves will be seen to be covered with an innumerable assemblage of minute globules of that gas, glistening like dew-drops upon grass.

It is true that plants and fish, with nothing else, would flourish for some time: but Mr. Warrington, who tried it, and to whom the most of our information concerning the

management, if not the invention of the *Aquarium* is owing, found, that after a time the plants in the ordinary course of nature died, and the fish refusing to eat them when dead, they began to decompose and so foul the water. At a loss what to do to stop the ravages of disease among his pets, he was driven to search in the book of nature—in its broad pages, the ponds and rivers—and find out how an all-wise Providence had provided for such an emergency. He threw a net and brought up from the bottom of a pond many dead and decomposing leaves, and to them were attached, busily at work in eating them, numerous little water-snails, nature's physicians. It is said that he was so overjoyed at the discovery, that he burst into tears; but this did not hinder him from securing a quantity of snails, and placing them in his tank, where, in a day or two, the water became perfectly clear, and remained so.

This, then, is the great secret of the *Aquarium:* the plants supply the animals with the oxygen they need; the animals supply the plants with carbon; and the snails and other scavengers—for there are others used in the *Aquarium*, as we shall see further on—remove vegetable matter, which would otherwise decay and destroy the animals.

In the *Aquarium* the snails are called to perform another duty that their former life has not prepared them for, but for which they are admirably adapted, and that is, cleaning the glass sides of the tank and keeping them so bright that nothing shall obstruct our view of its inhabitants. In time, the glass becomes covered with a deposit of minute plants, which belong to a class called *confervæ*. Between their branches there exists a little world of microscopic

animals, which form part of the food of our fish. The fish, it is true, eat the animals, but they leave still the *confervæ* that cover the glass, and prevent an unobstructed view of the habits of our pets. These plants are the natural food of certain genera of snails, and the principal business of the latter, when they are introduced into a foul tank, is to go to work and remove the *confervæ* from the glass, for our special benefit. There is one species of snail, called by conchologists *Lymnea stagnalis*, that will not perform its duty of cleaning the glass, but prefers, like a drone in the hive, to eat our more tender plants; but my readers will be glad to learn that this mischievous mollusc is not found in our country.

The great difference between a fish-globe and an *Aquarium* is, that in the one, we keep fish only, whilst, in the other we cultivate many beautiful and wonderful plants and animals which would not flourish if we changed the water often. This is a great *desideratum*, as changing the water endangers, to a certain extent, our carpets by the spilling; and then again, in an *Aquarium* the fish are not always subjected to continual excitement as they are in a fish-globe, where they must, as most likely everybody has observed, come to the surface to breathe, unless we change the water continually. This is an unnatural action in the fish, that is seldom or never seen in a pond or river. We can change the water continually, by having a jet in the form of a fountain, and where we can have this contrivance, as we can in the city of New York, fish will generally thrive without the use of plants; but, then, we lose the beautiful sight of the green foliage. There

are some fish and animals, however, that will not thrive in running water.

I have given the principles of the *Aquarium* in as plain language as I could, and without a knowledge of which it is worse than folly to attempt to keep one in order. The management of these pretty parlor ornaments is simple enough when we once get into the way of keeping it properly; and it is this ease with which it is kept that has made the *Aquarium* so popular in England, where a parlor is hardly considered furnished without one. They are even introduced into nurseries, to amuse and instruct the children; but though it may be amusement to the children, I can hardly think it can be so to the fish, as our youngsters are rather too fond of finding out "what's inside the drum that makes the noise" to conduce to the well-being of an *Aquarium*, unless it be well watched.

CHAPTER II.

VESSELS FOR AQUARIA.

Form of Vessel—Dimensions—Quantity of Stock to be introduced—Minnows attack Hermit-crabs—Overstocking—Balance of Nature—Materials for Tanks—Wood—Zinc—Iron—The bottom of the Vessel—Proportions—Octagon Tank—Circular Form—The Beginner's Tank—Breeding Jars—Covering the Tank—Ground Glass—Rock-pools—Mr. Warrington's Tank—Cement.

THE vessel which we are about to turn into an *Aquarium* may be of any size or shape, though those with flat glass sides are preferable, as they do not distort the vision, while vessels that have curved sides do: and in them, from the unequal refraction and the form of the vessel, objects are magnified and distorted in outline. As to dimensions best suited for a parlor *Aquarium*, I should recommend one containing from eight to twelve gallons for marine, and from two to twelve gallons for fresh water.

A tank that holds eight gallons will, however, be found the most convenient for either fresh-water or marine collections. I have several of this size in operation, in which I keep the following animals: In the first, which is a marine tank, I have three or four *Actiniæ*, about a dozen whelks, two or three univalve-molluscs (picked up on the shore at the same time), four or five minnows, one or two crabs of the genus *Lupa*, and sufficient vegetation in the shape

of *Ulva* and *Enteromorpha*, to keep the water in a fit state for the inhabitation of the animals. In my second tank I have *Actinia mesembryanthemum*, three specimens; *A. fragacea*, two specimens; *A. tigrina* and *Bunodes gemmacea*, of each one specimen; *A. marginata*, five specimens; minnows, thirteen specimens; three crabs of the genus *Lupa*, seven hermit-crabs, one or two *Serpulæ* and *Ulva latissima* and *lactuca*, *Enteromorpha compressa* and *intestinalis*, *Cladophora rupestris*, *Grinnellia Americana* and *Ptilota elegans*—but this is rather too full, though it seems to succeed. In my other marine tanks there is a little variety in the animal life; thus sometimes when I introduce hermit-crabs I omit the minnows, as I find that if I happen to forget to feed my minnows until they get ravenously hungry, they will attack the hermits, and after nibbling off their antennæ, at last drag them from their shells and attempt to eat them—but are oftenest disappointed, as a *Lupa* will be most likely to carry off the prize, though not to devour it in peace, for the fish will gather round and dispute the ownership of every morsel. In a fresh water *Aquarium* of this size, I usually place three small gold-fish, one sun-fish of not too great a size, two small dace, and three or four minnows; and in one tank I have (besides) three little black-spotted sun-fish. To these I add a dozen or two snails of the genera *Lymnea*, *Physa*, *Melania*, *Paludina* or *Planorbis*, and sufficient *Ceratophylum*, *Lemna*, *Chara*, or any other plant or plants to aërate the water.

When we wish, however, to keep larger fish than minnows of four inches in length, we should make use of a tank of proportionate size, and not be sparing of room,

as one of the worst accidents that can happen is the overstocking or crowding of the animals. The creatures I have mentioned above are about the proportionate number that will be found in a rock-pool or a portion of a pond of the size of the tank I use, that is to say, ten gallons capacity; and, indeed, in beginning to keep an *Aquarium*, it is better to rather understock it than run the risk of losing all our pets at once, as we shall be most likely to do if we introduce too many at a time. But when the tank has been in vigorous operation for some weeks, we can carefully introduce more animals until we have the balance of the animal and vegetable life complete. Let it always be made a rule, in the stocking and management of an *Aquarium*, to follow the teachings of nature as nearly as possible; for, of course, if we are not guided by the discoveries of those who have gone before us, we shall be the more apt to fail, and have to go over the same ground as they have gone over to arrive at the goal of their knowledge and practice.

The materials of which the tanks are usually made are, in the case of circular ones, glass alone; and in that of the oblong form the sides are composed of plates of the same material, and a frame of either wood, iron or zinc, although for small tanks wood is strong enough; yet, in regard to those of over a foot long, it would not bear the weight of the water unless it were made heavy and unseemly, or, if it did bear the pressure of the contained water whilst the tank was at rest, still, when it was moved, the cement about it would be liable to start from the glass in consequence of the bending of the wood

—and again, it might, if it were not well seasoned, warp, and so ruin the tank. Mahogany is the only wood that can be used with any safety for this purpose, as it is well seasoned in the forest before we get it. I have a tank made of thick mahogany which has been in use some months, and does not yet show any signs of warping, as it was very carefully made. I have, in some cases, made use of black walnut for small tanks, that is to say, those of fifteen inches in length; and they have stood very well; though I cannot recommend wooden tanks of any kind or size. Zinc is certainly superior to wood for *Aquarium* frames; but, still, there are objections to it: for if it be ornamental and portable, it is so brittle a metal in the cast state that any ordinary sized tank, having a frame made of it, would not bear any great pressure of water; while, if it were made with sheet malleable metal, though it would not break, it would be apt to bend, and so start the cement. Zinc is the metal most used in England for small *Aquaria*, as it is a cheap material; but I cannot recommend it for the purpose, and there is no reason why we should use it in preference to iron.

Iron is by far the best substance for the frame of an *Aquarium*, as it is cheap, strong, durable, and can easily be made ornamental and thin enough to be comparatively light, without endangering its strength at all. I have some tanks that are made entirely of iron and glass, which are extremely durable, but rather heavy, though that, as I have said before, is not necessary. The bottom can be made of a slab of some well seasoned wood, as mahogany or white pine, and covered internally with cement

of some kind and a plate of glass, so that the water never comes in contact with the wood at all, and there is no danger of its warping. Marble, soapstone, or slate can also be used for Aquarium bottoms, but they make the tanks heavy, and in the case of marble, expensive. But tanks made with stone bottoms will not travel well, from the difficulty of screwing the iron frame to the bottom tightly, without chipping it; and if it be not screwed tight, the cement will be apt to start away from the stone or glass when the tank is jolted at all. The best tanks, in this respect, I have seen, are some I have in which the bottom is made of cast-iron and covered internally with glass.

The proportions most approved of in England for the form of oblong tanks are twice as long as the depth or width, that is to say, forming a double cube, though, for marine *Aquaria*, I have usually found it advantageous to have the tank a little wider than these proportions, so as the more nearly to imitate a rock-pool.

When we wish to have an *Aquarium* of a more ornamental form than an oblong, we can have it octagon, like that in Plate I., Fig. 3, which is the representation of one contrived by Mr. P. H. Gosse. It is considerably wider at the top than at the bottom, so as to expose as great a surface as possible to the atmosphere. Again, we can make an ordinary chemist's bell-glass into a vase *Aquarium* by inverting it and setting the knob into a wooden stand, or use the glasses made for the purpose of covering cake, inverting one of them, and placing it in a wooden stand (as with the bell-glass), so that it can be turned round for observers to view the contained objects

on all sides. A representation of one of these is given in Pl. II., Fig. 1, stocked with *sagittaria*, *nitella*, *ceratophylum*, and *calitriche*, together with gold-fish and minnows. When one of this kind is placed on a tastily-made cast-iron stand with casters, it makes a beautiful ornament for a parlor window, and can be further decorated by having a hanging basket suspended over it filled with some pendant flowering plants.

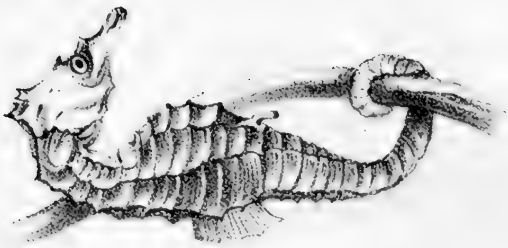
For a beginner, a good vessel for him to try his hand at the keeping of as an *Aquarium* is a glass jar, holding about two gallons—such as is used by confectioners, and having a wide mouth: the curved sides of such vessels, however, distort the figures of the fish when viewed through them, and therefore, perhaps, all things considered, it is best to get an oblong tank at once, in which he can see his pets in their real form and size. To the *Aquarium* tank, it is advisable to attach three or four glass jars, holding about a gallon each, to which stock can be removed at any time to observe it more closely, or these jars can be used for raising snails, growing *chara*, or any other plant. As adjuncts to a large *Aquarium*, the best things are a few of the flat-bottomed vases I have described above, as a sandy or gravelly bottom can be better placed in them than in jars, and besides, they can be turned in their stands.

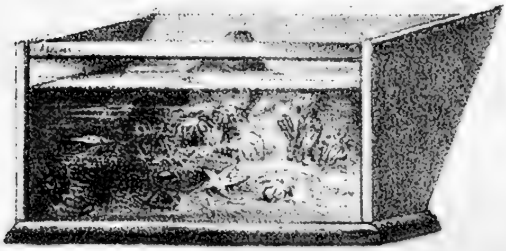
It will often be useful, and sometimes necessary, to cover the tank, in order to keep out dust, prevent undue evaporation, and guard against the loss of any of our fish, as many of them are apt to jump out; and to prevent such mishaps, I have found the best things to be plates

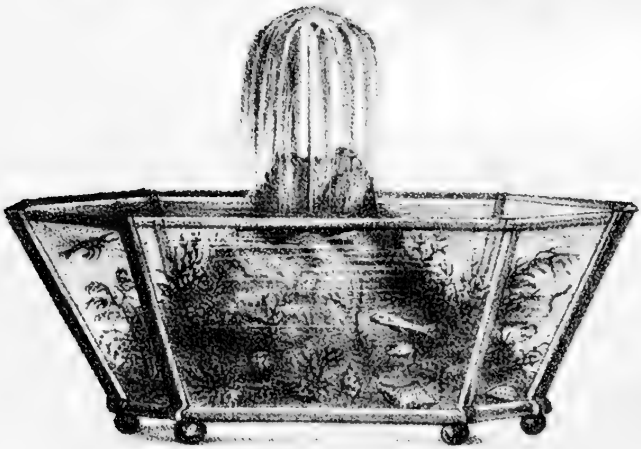
of glass, either ground rough or clear—though ground glass, perhaps, is the best, as it does not allow the direct rays of the sun to pass through it and impinge upon the water so as to heat it unduly, which would be deleterious to the animals, but rather diffuses the light so as to make it beneficial to the growth of the plants. To keep the fish within fresh water *Aquaria*, we may use lighter covers than glass; for instance, a piece of bobbinet stretched over a frame of wire. The gold-fish and dace I have found most apt to leap out, and sometimes the minnows will do so. Another good kind of cover can be made of perforated zinc; but it should not be painted in any way, as morsels of the paint will be liable to chip off, and falling into the water endanger, by its presence, the health, and, indeed, life of the fish. If we use glass covers, we shall, from time to time—that is to say, four or five times a day—find it necessary to leave them off, as will be made manifest from the close smell perceivable on lifting them off—the marine tanks especially, if there be much vegetation in them.

For the purposes of *Aquaria*, there are used in England several forms of vessels, such as vase-shaped and others, besides the ones I have mentioned. And for what are termed rock-pools—that is to say, shallow vessels imitating the natural receptacles of that name, and used for the purpose of keeping *Actiniæ*, glass milk-pans will be found very suitable: however, the form and size of the tank must be left, to a certain extent, to the fancy of the naturalist.

Mr. Warrington's tank (Pl. I., Fig. 2), is of a pecu-







liar form, and contrived for the purpose of a marine *Aquarium*, in order to keep deep-sea organisms, and for which it is admirably adapted. Mr. Warrington himself speaks of it as follows: "After five years and upwards experience, I have now adopted an *Aquarium*, the form of which consists in a four-sided vessel, having the back gradually sloping upwards from the bottom at an angle of fifty degrees. The chief peculiarity of this tank is, that it admits light at the top only; the back and sides are usually composed of slate." A tank of this form offers a sloping side, to which we can attach rock-work, and thus have a rocky shore, on which many animals like to crawl up to the level of the water—the *Actiniæ* and crabs will be found to be among this class.

A word as to the cement used in the construction of tanks. If the reader intends to manufacture his own (which I do not recommend him to attempt, without he has considerable mechanical knowledge), let him, on no account, use a cement containing either lead or lime, as they will both dissolve in the water, and so make the tank leak; and, also, they both, and especially the first of them, will contaminate the water and render it absolutely poisonous to the fish; for this reason, Roman or Portland cement is objectionable, as is also a cement often used by makers of tanks, at least in England, and which consists of a preparation containing white lead. It is true that I have used a tank put together with white lead, but it was carefully covered with other cement, and employed for fresh water only, sea water being more apt to dissolve out deleterious substances from the cement.

CHAPTER III.

PREPARING THE TANK.

Seasoning the Tank—The Bottom or Soil—Silver-sand not to be recommended—Pebbles—Kind of Soil used important—The Amateur not always to be governed by Books—Shell and Coral Bottoms—Rockwork—Cement for uniting Rockwork—Rockwork to be simply formed—Aspect—East aspect best—Morning sun beneficial—Some Fish can bear warmer Water than others—A Northern Aspect never favorable—Danger of letting the Water freeze—Minnows beneath Ice—Marine Aquaria not needing much Light a mistake—Mr. Warrington's Tank—Water to be introduced carefully.

When we have procured the vessel that we intend to turn into an *Aquarium*, and have ascertained that it is perfectly water-tight, and has been well "seasoned" (that is to say, the cement has been allowed sufficient time to harden, and the tank several times filled with water and emptied, after letting the water stand in it some hours to dissolve out all soluble matter which may have been in the cement used, and which, if allowed to remain, would endanger the lives of the animals, if any were introduced before this was made certain), we then proceed to prepare it for the reception of the animals, and to do so, we must begin with:

The bottom.—This is to be made by placing well washed river sand, or fine gravel, upon the slate, glass or other base of the tank. Silver-sand, such as is sold in shops,

is sometimes recommended, and I have used it for this purpose: but it requires a great deal of washing to make it fit to be placed in an *Aquarium;* as, after even a dozen good washings, I have found that it still slightly tainted the water, and even if we could perceive no color imparted, yet there is apt to be lime, or some marine salts, dissolved out after a time, which renders the water injurious to the fish and other inhabitants. I, therefore, cannot very highly recommend silver-sand for a bottom to the tank, though it may answer when so used. And as a general rule, all colored sands should be rejected as worse than useless. The common red gravel, which would look well in a tank, must not be used, for the reason that it is ferruginous—that is to say, it contains iron, which would soil the water of a red color. When saying that silver-sand was not applicable to *Aquarium* bottoms, I meant more particularly fresh-water tanks: for I have used it in marine ones, after well washing it, so as to remove all dirt, and with advantage, as there are several crabs and other animals that delight in burrowing in it; still, even after well washing, this sand is apt to retain some of the salts it takes up on the sea-shore, and which, in a marine *Aquarium,* would do no harm, yet would, in a fresh-water one, render the water brackish, and so destroy the plants certainly, and perhaps several of the animals. We therefore procure a perfectly clean specimen of sand, place it on the base of our tank, to the depth of at least half an inch, though I have found that, generally, an inch is the best depth, and leaving it in some places exposed, place over the same a layer of small pebbles, to

keep it in place ; and for this purpose I have found the white quartz pebbles, that are picked up on the sea-shore, the best—but even they, as well as the sand, must be well washed, to remove all salts or decaying animal or vegetable matter. The sand is useful in the case of the fresh water *Aquarium* to set the plants in, and the pebbles to keep them in place and steady.

Though it may at first sight appear to be so, it is not a matter of small importance as to the amount and quality of the soil or bottom employed for *Aquaria;* and though many of the fresh-water plants have no apparent roots, and others seem to flourish just as well when they are torn away from the roots and thrown into the water to take their chance, yet it is certain that some plants have peculiarities that fit them for growing in a soil of a particular kind, and, consequently, they will not flourish, though they may, to all outward appearances, grow in a soil of a different description : thus, the glass-wrack *(Zostera marina)* although it seems to grow in the sand beneath the mud, will not flourish in an *Aquarium* unless there be that mud ; and, in the fresh-water collection, there is the water plantain *(Alisma plantago)*, the water violet *(Hottonia palustris)*, the water lilies, both white and yellow *(Nymphæa alba* and *Nuphar luteum)*, and the common arrow-head *(Sagittaria sagittifolia)*, besides many others that will not flourish in any but a deep soil at the bottom of the tank. Therefore, the soil must be regulated according to the plants which are intended to be grown in the *Aquarium.* The kind of soil or bottom that I have described above will be found to be the best to be placed in a tank for ordinary pur-

poses, where we intend to grow the floating plants, as *ceratophylum*, *chara*, *calatriche*, etc.

The amateur naturalist must, however, trust, in a great part, to what he will acquire during his own experience to guide him in his after attempts: and must not be discouraged if he fail once or twice, for it will be a wonder if he succeed on the first trial. He may get many invaluable hints from books, but cannot always be governed by what his author has given him, for instances may occur which the writer has not taken into consideration, and, then, what is the neophyte to do? He must, as I said before, be governed by his own experience: for, do we not find that Mr. Gosse condemns red sand and silver-sand as certain to stain the water? whilst Mr. Hibberd, on the contrary, observes: "I have two tanks now at work, both bottomed with such material" (red sand and silver-sand) "and the water preserves a crystalline brightness. I have also a marine tank, in which the bed is formed of common silver-sand and garden pebbles; it has been in use nine months, with no unfavorable results." Thus Mr. Hibberd and I have used silver-sand, and it has succeeded; and yet I have also used it, and it has failed from some unlooked for and unknown reason. All I can, therefore, do is to give my readers the result of my experience in this branch of the subject, and leave it to them to experiment for themselves. I have heard of, though I have never seen, the bottom of a fresh-water tank entirely composed of marine shells and pieces of coral. These, of course, are extremely unsightly, although in a marine tank they are proper enough, if they are arranged tastily; though I must confess to one weakness, and that is, that I have been so

unmethodical as to mix with the gravel and pebbles of one of my fresh-water tanks the empty shells of *Anomia*, the beautiful little golden and silver-colored shells so common on some parts of our coast.

Rockwork is the next thing to be attended to after we have got the bottom or soil of our tank arranged to our satisfaction. In a fresh-water *Aquarium* I do not recommend much of it: yet if your taste, reader, leans that way, be satisfied with a simple pile of stones in the centre, or a *cromlech*, made by placing two stones on the bottom at a distance from each other and laying another across them—thus forming a rough arch, under which fishes may retire when they are so disposed. Stones may also be fastened together in the form of one or more arches by means of some cement, always remembering that any metallic or lime cement is injurious, and will be sure to taint the water to the detriment of the inhabitants. The best of all cements for this purpose is made by melting together one part, by weight, of rough *gutta-percha* and two parts of common pitch. This cement holds well to stones and does not foul the water, besides it is to a certain extent flexible, thus not being liable to break on receiving any sudden jar. The rock I have found to be the best for the purpose of the *Aquarium* is either semi-crystallized quartz or white feldspar, the latter of which can be obtained in any quantity on New York island. It is best, perhaps, when it can be done in fresh-water *Aquaria*, and certainly in marine ones, to dispense entirely with the use of cement for the purpose of uniting the rockwork. I have never found it necessary to fasten the rockwork to the bottom

of the vessel, but merely to sink it well in the sand and gravel, so that it may be held upright, as an *Aquarium* is not generally intended to be moved; and if rockwork be well set up there will be no danger of its falling, unless the tank gets a shock that would be dangerous to the joints. A very good plan to make up rockwork in a marine *Aquarium* is, to set up two stones for a *cromlech* (as I have described) and use, for the upper flat one, a large stone upon which one or more kinds of sea-weed are growing, and an end of which may be made to project a little above the surface of the water, for the purpose of allowing crabs and other animals that prefer it to come out into the air when they wish. I have found such stones as I speak of which have had growing upon them plants of *Ulva*, *Enteromorpha*, *Ptilota*, *Cladophora*, and one or two others; such stones can be procured on any rocky coast where the *Algæ* are plentiful: for instance, on the shores of New York island, as, indeed, I shall more particularly mention in the chapter on collecting specimens.

Aspect.—Having now prepared the bottom and set up the rockwork of our miniature pond or ocean, we must find out if we have it placed in the best position, suitable to its well being, as it is never advantageous to move the tank when it is once arranged and filled, as doing so may stir up the sediment that collects at the bottom, and, besides, frighten the fish. If we have a window facing the east, and from which the sky can be seen without dislocating our necks, we should place our *Aquarium* there, as both animals and plants like to get the rays of the morning sun, and always thrive the better for them. We must guard, however, against the heating power of the rays:

that is to say, only expose the tank to the *morning* sun, and not to his midday powers, as they would be liable to heat the water to a temperature that would be uncomfortable, if not dangerous, to the fish ; therefore, if we do not wish to subject our pets to a process of slow boiling, we shall do well to shield them from the sun. If we have not a window looking on the east, a southern aspect will answer nearly as well, only we will have to be more particular as to shading the tank from the direct rays of the sun, otherwise the water would soon become heated, and such a bright light, though it would be advantageous to the growth of the plants, would also increase the quantity of *confervæ* that thus accumulates on the glass quicker than the snails can remove it.

The gold-fish, however, from being natives of warm climates, thrive best in water that would be uncomfortably warm to other species. Many of those exposed for sale are reared in water which receives the waste steam from factories, and is often kept at as high a temperature as eighty degrees of Fahrenheit.

A northern aspect is never favorable for an *Aquarium*, and a westerly one is the worst of all. In either of these positions the plants, it will be perceived, do not grow vigorously, and the fish are never as lively as in a southern or eastern one. In winter we can expose our tank longer to the direct rays of the sun, especially if it is not kept in a warm room, as we have to keep up an eternal summer for our animals and plants to make them flourish ; once let the water freeze, and we will perceive, especially in a fresh-water collection, that the latter will droop and die, and the fish become slow in their motions. Gold-fish will not

bear as low a temperature as our native species from reasons that I have mentioned before. However, I have had minnows living beneath a cake of ice an inch thick in my tank. Of course, if we allow the water to freeze, we shall endanger the bursting of the vessel from the expansion that water always undergoes when passing from the liquid to the solid state. Mr. Hibberd, in his useful little book on the *Aquarium*, mentions that he finds that "a northerly aspect will do very well, say from May to October; but during the winter months a tank in such a position would be feeble and want watching." A good plan is to place a fresh-water tank close to the window, and during most of the year leave it open; this, of course, cannot be done during the winter, but the sash can be lifted for about an hour a day, and you will find that the fish thrive the better for it. It is mentioned in most of the books on the subject, that marine *Aquaria* do not require much light; and Mr. Hibberd recommends the placing of them behind fresh-water tanks, so that they receive little, if any, light through the sides. This may be advantageous for the deeper water species, but, in general, where I have used *Ulva*, *Enteromorpha*, *Grinnellia* and *Cladaphora*, with hermit-crabs, minnows and *Anemones*, I have found that one or two hours a day of bright sunlight is highly serviceable to the growth of the plants, and exhilarates the *Anemones* wonderfully, making them expand and exhibit their beauties in a fine manner. In the sea, it is true, that the light falls through the *surface* of the water, and on this principle is Mr. Warrington's tank contrived, and in it sea species thrive wonderfully. This fact should also hold true in regard to fresh-

water plants and animals, but we find no writer recommend those tanks for their preservation, but rather advocate the clear sides and a bright light. The marine species, also, that we introduce into an *Aquarium* are mostly those from shallow water, where they receive plenty of sunlight. Mr. Warrington's tank would be found useful, no doubt, for the keeping of deep-sea forms that will not thrive in the light; but we have only to remove our collection away from the window and it will do as well: and, besides, we do not lose the one glass side that is indispensable to a clear view of the contained forms.

When, then, all else is prepared—that is to say, the bottom, rockwork and plants—we are ready to introduce the water, which it will be seen requires some care. If we were to pour it in at once from a pail or pitcher, there would be danger of uprooting the plants or overturning some of the rockwork: therefore, it is a good plan to pour it into the tank from a common garden watering-pot, with a fine rose attached, which will separate the water into several small streams, and make it fall in the form of a delicate shower—in this way exposing as large a surface as possible to the air, so that it may be absorbed, and hasten the preparation of the tank, for the plants will not then be required to be put in to aërate it as long a time before the animals are introduced. Some writers recommend the pouring of the water from a pitcher held in one hand upon a plate held slanting in the other over the tank. This splashes the water into several streams, and aërates it well; and when the watering-pot cannot be conveniently used, answers the same purpose.

CHAPTER IV.

THE FRESH-WATER AQUARIUM.

Marine and Fresh-water Aquaria compared—A Fresh-water Aquarium to be recommended to a Beginner—The Reasons why—Fresh-water Animals and Plants easily procured—Transformations of the "Polliwog"—The young Frog—Transformations of the Toad—"The Toad, ugly and venomous, bears yet a precious Jewel in its Head"—Tadpoles excellent Scavengers—Tadpoles amateur Naturalists—Value of an Aquarium to the Microscopist—Value of an Aquarium to the Naturalist—Sticklebacks and their Nests—Caddis-worms and their Cases—Cases for running Streams—Amusement for the Country—A home-made Aquarium—Simplicity of the Aquarium—The Naturalist's Diary.

Though a fresh-water collection cannot vie with a marine one in the strangeness of the varied forms of its animal inhabitants, or in the brilliancy of the color of its plants, yet, when well arranged, I consider that a fresh-water *Aquarium* can be made as ornamental, if not more so, than a marine one, by way of a piece of furniture for the parlor; and though, in our miniature ocean, we have the many-tinted Anemones and curious crabs, yet, in our crystal pond, we have the universally favorite and never-to-be-left-out gold-fish, with their graceful form and colors, that vie with those of any of the inhabitants of our salt-water tank—and then we have the curious little sticklebacks, and the gorgeous sun-fish, with his sides reflecting, in the sun-light, all the tints of the rainbow, and his majestic motion,

slowly gliding by in kingly majesty, for the sun-fish is slow, and seldom hurries himself; and we have that fresh-water lobster, the craw-fish, and the fresh-water shrimps.

To a beginner, I should decidedly recommend her, my fair reader (for these few hints, as to the management of the *Aquarium*, are not any more especially addressed to the gentleman than to the lady part of the community, whom I hope soon to see taking as much delight in the fitting up and management of these beautiful parlor ornaments as their sisters on the other side of the Atlantic), to start with a fresh-water *Aquarium*, in preference to a salt-water one, for several reasons. *First*, the stock for it is easier procured, and, if any accident should happen, can be sooner renewed, and the same thing may be said of the water. *Second*, I have found the fresh-water *Aquarium* to be much easier to start, and more readily kept in order. *Third*, many facts may be learned from the keeping of a fresh-water *Aquarium*, that we shall find very useful when we come to start a marine one—facts that can only be got at from the keeping of a marine collection for some considerable time, at the risk of losing many valuable objects that cannot be procured as easily as fresh-water stock; for every one knows some quiet little pond or brook in the country, that is accessible, and every such pond or piece of water will be sure to yield something for a collection. Even if it be but a pond in which frogs abound more than any other animal, yet there we will be very likely to find some plant that may answer for *Aquarium* use—water-beetles, caddis-worms, or some other small, but not to be despised, creature that we may

pass an hour or two watching, to add to our stock of knowledge, or even to amuse us for a while, and dispel *ennui*. If nothing else is to be found, let us take some half-a-dozen tadpoles, or, as the country boys call them, "polliwogs" (tell me, ye who are learned in such things, is it spelt right?) and watch their wondrous transformations from the little seeming black ball, with a minute tail, through its time of cutting its first teeth, that is to say, its first legs, always the hind ones, until it gets its fore legs perfect, and shedding, gradually, but surely, its tail, it bursts at last on our vision an entirely different creature from the little shapeless ball of flesh we took from the pond—a perfect frog, and perhaps we may have the luck to hear his first croak, which he gives remarkably well, as if he had been practising *sotto voce* ever since he first waggled his tail, among his hundreds of brethren, in pond or stream, and seems not to be ashamed of the sound he makes either. A young frog, just after he has shed his tail, and before he has begun to grow into froghood, is a more beautiful object than you would imagine, who have only seen him in his native pond. I once had a little fellow, scarcely an inch in length, who would sit upon the highest point of rock that projected above the water, in my *Aquarium*, where he really formed a very ornamental object, with his light green back, copper-colored stripes, and bright twinkling eyes, which he would wink at me in a most audacious manner, seeming to enjoy himself amazingly. I have also watched toads during their transformation, from the tadpole state, to that of the perfect animal, for they, as well as frogs, pass their

youth as tadpoles, in the water, and funny little creatures they are, when they first get their legs. Some I have found, scarcely half an inch in length, with delicately mottled grey and black backs; and though not so brilliant in color as their cousins, the frogs, are pretty animals, whatever Shakspeare may say to the contrary. I can never agree with him that the toad is "ugly and venomous." Ugly it is not, according to my mode of viewing it, and though modern naturalists may have found out that the liquid secreted by the skin of the toad is venomous, yet I consider that he has been very unfairly treated when condemned to the companionship of witches, wizards and such like, to be made use of, when wanted, to help in the formation of such a stew as was prepared for the special benefit of Macbeth by the weird sisters. That the toad "bears yet a precious jewel in his head" is not true, in the common acceptation of the term, but he is himself a jewel of great value, being, like the frog, one of nature's scavengers, ministering to the well being of us all, in removing substances which would otherwise decay and cause disease. Indeed, I have found that with having three or four "tads," I have been able, for a length of time, to dispense with snails, as they will not only eat the decaying vegetation, but will lick the glass clean with their formidable lower jaws, which are armed with several fine sets of teeth. And they will do what most of the snails will not, they will eat decaying animal matter; for I have found fish, that have died from some accident or other, all eaten but their bones, by my friends, the "tads." A friend informs me that he has been in the habit of clean-

ing the skeletons of birds for his collection, by suspending them in a jar of water, in which he placed five or six good sized tadpoles, and, in about a week, these creatures had removed every particle of flesh from the bones, so that the skeletons were beautifully clean and white.

What a treasure to the microscopist is a fresh-water *Aquarium*, for in it he can find numberless treasures to delight his eyes, that he would otherwise have to search days for, in visiting many ponds and rivers, and wearing out many pairs of shoes. It is to the Zoölogist what the greenhouse is to the Botanist, a receptacle in which he keeps his choicest species, and within whose small inclosure he may observe and study the habits of many animals that dwell at the bottom of lakes and rivers, and, therefore, could not be seen else. Not only has the *Aquarium* been an endless source of amusement to hundreds, but it has been of infinite value to the naturalist, and has aided in the advancement of the science of natural history in an immense degree, bringing the operations of nature in the depths of her oceans and rivers home to our firesides, and popularizing the study of the beauties and wonders of the Creator's handiwork, so that the youngest may learn to reverence and worship him in his works. For instance, the habits of the common little stickleback could not well have been observed without some such contrivance, and now nearly everybody that has had a fresh-water *Aquarium* in operation for any length of time, has had the pleasure of viewing this curious little creature build his nest and bring up his young—for it is the male that builds the nest and takes charge of

the eggs until they are hatched and the young come forth, and then he guards and watches over them with all of a parent's love. Then the curious caddice-worms, as they are called, without the glass sides of an *Aquarium*, we would not be able to see them build their grottoes and cases, and go through their metamorphosis until they become the perfect insect—the case-fly. They are funny little fellows, these cads; I have some that have cases built by laying three sticks across each other so as to form a triangle; upon this another triangle of sticks is placed, but a little shifted, the next a little more so, and so on, until we have a case with a rough and pointed exterior, covered with projecting sticks of all colors, but of a beautiful and comfortable smoothness inside. And I have others that have five-sided cases formed of three or four tubes, fastened end to end, which are made of pieces of leaves cemented together with a water-proof cement that would be invaluable to the manufacturer of *Aquaria*. And these cads are gentlemen of taste, too, for instead of forming their cases of leaves of one sombre brown hue, they will make one-third of its length of dark-colored leaves, the next of light-colored, and the last of green. One of these wonderful little creatures, who happens to dwell in a running stream, finding that his case, if made of wood, would be too light, and be carried away by the force of the water, attaches to some part of it a small stone, of such a weight that he may readily drag it about with him, but still heavy enough to resist the force of the stream; or he will make his case of empty snail-shells, or entirely of stones, sometimes attaching a piece of wood

to float it in still water. So with the millions of microscopic animals that abound in every pond and ditch—without the aid of some such contrivance as an *Aquarium*, we would not be able to keep them in any quantity so as to study them at our ease.

Reader, when you are staying in the country, and missing the flag-stones of the city, confessing yourself "bored" with nothing to do, and feeling the want of balls, parties, theatres and operas, do as I shall herein bid you, and my word for it, all your *ennui* will be dispelled very quickly. Get a glass jar of some kind—a preserve-jar will answer the purpose—let it hold about a gallon, and cover the bottom with clean river sand and pebbles. Then go to the nearest pond, and get some of the plants that you will be almost certain to see growing there beneath the water, and place them in your jar, planting those that you find growing in the deep soil at the bottom of the pond in the gravel of your *Aquarium*, leaving the others to float, and fill it up with water. Now return to your pond, and search at the bottom, and on the under sides of the leaves of the aquatic plants, for the snails that you will be nearly certain to find in those positions, and when you have collected about a dozen, throw them into the water of your jar. When your *Aquarium* is thus prepared for the reception of other live stock, take a small net, made by stretching a bag of bobbinet over a wire ring, and attached to a long handle, proceed to your pond, plunge your net, and drag it for some few feet along the bottom; take all it contains, when you draw it up, and after washing, place it in your jar along with any fish

and tadpoles that you have been lucky enough to catch, or that you can persuade any of the country urchins, for a few cents, to procure for you; and then you will have an *Aquarium* in full vigor.

Now, tell me reader, is an *Aquarium* such a deeply scientific affair and is it so very difficult to manufacture? I think that you will agree with me after one day spent in searching for objects and the many hours you will be sure afterwards to spend in watching your happy prisoners, that you are not quite so much "bored" as you were, and that your walk in the fresh air has done you a great deal of good, and banished all wishes for a city life again. When you have got your *Aquarium* under way, then take this or any other book that treats of the subject and see if you can find out the names of your plants and animals. But let me advise you to trust more to your own observation than to what you can learn by sitting down to read a book without looking with your own eyes and not those of your author, for if you learn to observe for yourself you will perhaps the sooner, but certainly the surer, become acquainted with the habits of the many wonders that you have had the satisfaction of catching. I have found it a good plan to keep a naturalist's diary, a book wherein I write down the history of my *Aquarium* and the changes or facts that I remark of my pets every day. To this book I may at any time refer, and this plan I recommend heartily to the consideration of my readers.

In this way we shall be writing a book that will always be of use, for there are always little facts that slip our

memory and may either be useful to ourselves when starting a new tank, or to our friends, if they wish to do so.

All things considered, the fresh-water collection is, by far, the best for a beginner; and though the colors of the contained objects are not so brilliant as those in the marine tank, yet it will well repay us to watch the many curious and wonderful forms as revealed to us in the fresh-water *Aquarium*.

CHAPTER V.

PLANTS FOR THE FRESH-WATER AQUARIUM.

The bottom of an Aquarium to be planted in the same manner as a Garden—Water-cress difficult to make flourish—Arrangement of Plants—Common Arrow-Head cultivation by the Chinese—Arum—Water-lilies—Water-shield—Sweet Flag—Forget-me-not—Sun-dew—Ferns—Valisneria Spiralis at West Point and Fishkill Creek—Hornwort—Its rapidity of growth—Water Starwort—Anacharis Canadensis—Remarkable power of propagation—Appearance in England—Choking up the Rivers—Chara vulgaris—Nitella flexilis—Circulation of Sap-Water—Crow-foot—Awl-wort—Spiked Water-milfoil—Marestail—Villarsia—Buck-bean—Water-violet—Water Speedwell—Water Soldier—Pondweeds—Duckweeds—Frog-bit—Grouping Plants.

Having our tank prepared, as to the bottom and rock-work, according to our taste, we proceed to introduce the plants. In doing so, we plant the bottom of our tank as we would a garden, that is to say, placing the roots of such plants as thrive best at the bottom, in the sand beneath the gravel, as it is in this that they must grow—the gravel only serving to keep them in place and retain them in an upright position. Dr. Lankester, in his little book on the *Aquarivarium*, gives us quite a long list of plants that may be used with advantage in the *Aquarium*, many of which I have tried and can recommend; but there is one he mentions which I have never been able to make succeed, and that is the common water-cress (*Nasturtium offi-*

cinale). This plant is an inhabitant of running water—I have not been able to make it grow well in the still water of an *Aquarium;* but yet, have kept it alive for some time by rooting it very deep in the mould at the bottom; besides, I find that snails are very partial to it, and will leave the *confervæ* and other plants in order to devour it.

I propose to arrange the plants in the following manner: *first*, those used as centre pieces and for the purpose of ornament; *second*, those planted on rockwork out of the water and not flourishing when submerged; *third*, those submerged and planted at the bottom; and, *fourth*, those floating without any attachment.

Common Arrowhead.

I. ORNAMENTAL PLANTS NOT AËRATORS OF THE WATER.

Common Arrowhead *(Sagittaria sagittifolia.)* This is decidedly the best plant for a centre piece and can be

found in most of our large ponds. It has elegant leaves of the form of barbed arrows and of the glossiest green color, the flowers rising in pyramidal form from the water and borne upon stout, fluted stems. The flowers are three-petalled, white, with a flush of violet towards the centre, from which rises a granulated boss of green, that adds much to the beauty of the flower by the contrast of the tint to that of the petals.—This plant is extensively cultivated among the Chinese, not for its beauty, but for the sake of the bulbous root, which fixes itself in the solid earth below the mud and constitutes an article of food. The bulb, among the Chinese, seems to grow to a larger size than with us; but it could readily be made available, if some enterprising market gardener were to attempt the growth of this succulent root. The size might easily be increased as many of our garden herbs have been by cultivation; and then again, the arrowhead will flourish in damp situations where other useful plants do not grow.

Arum *(Calla palustris)* is another plant which grows well in the *Aquarium* according to Mr. Noel Humphreys, though I have not tried it myself. It is, I should judge, rather too large, and, together with the next mentioned, more suited for very large tanks than for the small lakes we place as ornaments in our parlors. The leaves of the *arum* resemble in form those of the *sagittaria*, but the flower is trumpet formed, with a yellow pistil, the petal being violet-striped, with one side of the lip falling gracefully over.

The Water-lilies (*Nymphæaceæ*), of which there are three—one white (Pl. II., Fig. 3), and two yellow. They

are the sweet-scented water-lily (*Nymphæa odorata*), and the two yellow pond-lilies (*Nuphar advena* and *Kalmiana*), and are common in our larger ponds. They look ornamental when in bloom, but when not in flower, only fill up the tank; and, besides, require to be very deeply rooted. They also die down in the winter, and, therefore, are objectionable in that season.

The common Water-shield of our ponds (*Brasenia peltata*) is allied to the lilies, and grows in the same positions. The leaves float upon the surface of the water, and are oval in form, with the stalk attached to the centre of the under side. All the submerged portions of this plant are covered with a gelatinous mucus that prevents contact with the water. The process of opening of the leaves is very curious in this plant, and worth watching. The flowers are small, and of a dull purple color.

Some of the reeds and rushes, as the common Calamus or sweet flag (*Acorus calamus*), may be introduced, but require to be deep-rooted in the sand or soil of the tank; and even then will not be likely to flourish, though they look well in a large collection while they live.

II. PLANTS PLACED ON ROCK-WORK OUT OF THE WATER.

On the rock-work can be grown the beautiful blue forget-me-not (*Myosotis palustris*), the Sun-dew (*Drosera*), of which genus there are five species found in the United States, and several other plants; though I do not advocate the use of any of those plants that are simply for show, taking no part in the economy of the tank, and

when the petals of their flowers fall, are positively injurious, as they add more refuse vegetable matter for the snails and other scavengers to remove. The ferns, from belonging to the class of plants called *Cryptogamia*, or flowerless plants, are free from this objection to their use, and are very ornamental when arranged with taste on any rock-work projecting above the water's edge. Mr. Hibberd, in his book called "Rustic Adornments for Homes of Taste," gives us a list of such of these beautiful plants as may be used by way of ornament for our *Aquarium*.

III. PLANTS USED FOR AERATING, BEING COMPLETELY OR PARTLY SUBMERGED.

Foremost among these truly useful plants, stands the almost universal *Aquarium* inhabitant,

VALISNERIA SPIRALIS (Pl. III., Fig. 2). It is certainly one of the most useful of all the aquatic plants, though, perhaps, not the most ornamental, even of the submerged ones, which are generally thought to be not so graceful in their outline as their relations of the shore. It is found, I understand, at several places near New York city, one of which is at West Point (and is mentioned by Prof. Bailey in Silliman's Journal, vol. xlii. p. 89, note), on the shores of the Hudson River, where we have a curious assemblage of fresh-water and marine vegetation; the *Valisneria*, together with *Potamogeton*, growing just below high-water mark, and *Enteromorpha*, *Ectocarpus*, etc., from that point to below low-water—thus showing that the fresh, being lighter than the salt water, floats, as

it were, on its surface. I have received plants of it from the mouth of the Fishkill Creek, where Dr. Torrey informs me it grows in such profusion, that he has frequently found a difficulty in pushing a boat through its tangled leaves. This plant is named in honor of an Italian naturalist, by name Valisneri. It in appearance resembles a grass, having long fronds, or leaves, starting from a deep-set root in the soil at the bottom, and growing upwards in the water towards the surface, often falling over in graceful curves, forming "groves sequestered," through which the fishes may roam. From the knowledge of its natural mode of growth, we learn that it will flourish only when well rooted in the sand and gravel at the bottom of the tank; indeed, I doubt not that it would grow still better if we used a layer of soil placed beneath the gravelly bottom of our *Aquarium*. This plant can be easily distinguished on account of its resemblance to a wide grass, as there is no other fresh-water plant like it in form, the common sea-grass (*Zostera marina*) being somewhat like it in appearance; but that grows only in the sand of the sea-shore. The *Valisneria* is propagated by off-shoots, which is a peculiar feature of the order *Hydrocharidæ*, to which this plant belongs; and Mr. Lloyd mentions, that from six small roots he procured, during one summer, no less than thirty-two healthy plants, all of which blossomed freely. One of the female flower-stalks of these plants he measured, and found it to be as much as five feet in length. This is one of the plants in which the circulation of the sap may be observed under the microscope.

Hornwort.

The Hornworts, of which there are supposed to be several species, though Gray seems to think otherwise, come next in our list. The commonest, however, if there be several, is the *Ceratophylum demersum*, and is found in slow-running streams and ponds all over our country. It grows quickly and well in confinement, and, together with *Chara*, *Callitriche*, and *Anacharis*, flourishes just as well free as when rooted; indeed, this is the case with a great many fresh-water plants. In one of my *Aquaria*, I have a plant of the Hornwort which, when I placed it in the water some six months since, was a little broken sprig about six inches long, and it has now filled up more than half the tank, and promises to crowd to the wall the other slower growing plants. The Hornwort may be readily distinguished from having long, slender, filamentous leaves, arranged in whorls around a central stem, which are also forked two or three times. We can tell it from

Chara or *Nitella*, as those plants have no real leaves, but simply stalks in place of them around the stem, in whorls like the *Ceratophylum*. It is a very graceful plant, and an excellent aërator of the water. I have often used it alone or with *Lemna* to stock a tank; indeed, my first *Aquarium* was a small jar, with two plants of Hornwort, two tad-poles, one small frog, and half a dozen snails.

The water-starwort *(Callitriche verna)* is another class of these useful and, at the same time, ornamental plants for the *Aquarium*. There is a variety of this species called *platycarpa*, as well as two other species, *C. pedunculata* and *C. autumnalis*, found in the United States. I have been as yet able to find the water-starwort only in small quantities near New York city, but it is said to be very common in some parts of the State. This plant may be distinguished from its presenting a star of four leaves on the water's surface, of a light green color. A good plan is to throw a rough gathering of this plant into water, and, after well washing it, pull off only the bright green heads with about three or four inches of stalk attached, and cast these into our tank to take their chance; the plant soon spreads itself over the surface of the water, and gives a healthy green shade that is good for the animals, obstructing the heating rays of the sun.

Anacharis Canadensis (Pl. III., Fig. 1), *A. alsinastrum*, *American weed*, or, as it has been also called in this country, *Udora Canadensis*, is one of the most vigorously growing of the aquatic plants that we can introduce into an *Aquarium*, and is, at the same time, extremely common. Mr. and Mrs. S. C. Hall, in their interesting little "Book of the

Thames," quote a pamphlet by William Marshall, Esq., where, when speaking of the *Anacharis*, he says—"The intruder is so unlike any other water-plant, that it may be at once recognized by its leaves growing *in threes* round a slender stringy stem. The color of the plant is a deep green; the leaves are about half an inch long by an eighth wide, egg-shaped at the point, and *beset with minute teeth which cause them to cling*, so that whenever the plant is disturbed fragments are broken off. Although it cannot at present propagate itself by seed (all the flowers being male) its powers of increase are prodigious, as every fragment is capable of becoming an independent plant, producing roots and stems, and extending itself indefinitely in every direction. Most of our water-plants require, in order to their increase, to be rooted in the bottom or sides of the river or drain in which they are found; but this is independent altogether of that condition, *and actually grows as it travels* slowly down the stream, after being cut." That this weed is "a foreigner" to England there can be little doubt. Its property of "holding on," and, as it were, crying, "don't give up the ship," marks it as an American. And again, "weeds very closely resembling, if not identical with it, are found in American rivers. Mr. Marshall is of opinion that it is an importation from North America: and that, probably, its first visit was paid to us in a load of American timber. He considers that all attempts to 'get rid of it' must be futile; *that it never can be eradicated:* and that all we shall be able to do is to 'keep it down.' Its rapid growth is one of the marvels of nature. It is becoming a serious evil: the Commissioners of the Thames should lose

no time in grappling with the common enemy." It has only been known ten years in England, and yet has already become a common weed, affecting the traffic of rivers and canals, impeding the currents of minor streams, and filling up isolated ponds, thus growing in both running and still water, and though it seems to prefer the former, grows the more rapidly in the latter. It has already rendered the Thames in some parts almost impassable.

The above supposition of Mr. Marshall's of its introduction into England seems, however, not to be the correct one, as I find the following given in a little book on the *Aquarium*, published by Messrs. Dean & Son, of London: "One of the Cambridge professors, having received a plant from a friend in Canada, kept it for some time in a glass jar: but not seeing any particular use in retaining it, threw it away down a drain that emptied itself into the Cam. The following year a great stir was made about a new weed, which was fast choking up that river; and, upon inspection, the professor was much surprised to find in it his old acquaintance, which he had the year before parted with so unceremoniously."

The Characeæ are all of them excellent plants for use in an *Aquarium*. Dr. Lankester gives the following general description of the species: "All the species are easily known in the water by consisting of a central branch, which is composed of elongated cellular tubes, and at the junction of each tube with the other it gives off a series of branches, which surround the primary tube in the form of a whorl. In the axils formed by the branches with the primary stem, the parts which represent the stamens and

pistils of the flowering plants are seated. These parts are of two kinds, and are called "mucules" and "globules." The mucules are green, and represent the pistil, whilst the globules are of an orange color, and represent the stamens. The globules contain cells, in which are contained small moving worm-like bodies, and are interesting objects under the microscope."

The Flexile Nitella *(Nitella flexilis)* is the representative of this order which I have found most common near New York city, and differs from the other common species *Chara vulgaris* (Pl. III., Fig. 3) in having its stems composed of one single cell, whilst those of the *chara* are made up of several twisted cells, united side by side. In this class of plants, as in the *Valisneria*, the circulation of the sap in its cells may be readily observed under the microscope, only in a superior degree. The stems of the *Chara vulgaris*, from being coated with a deposit of calcareous matter (whence its common names, stonewort and brittlewort), have to undergo preparation before the circulation can be well seen: whilst with the *Nitella* it is simply necessary to place it between two glass plates, with some water, and arrange it under the microscope to see the circulation distinctly. The *Characæ* are good growing plants, and look very graceful in an *Aquarium*, the light green color of the *Nitella* contrasting well with the dark green of the *Chara vulgaris*, *Ceratophylum* and other plants, and as aërators they cannot be surpassed. As I have mentioned before, they have no true leaves, but stalks replacing them.

The White Water Crow-foot (*Ranunculus Aquatilis*)

is a pretty plant for an *Aquarium*, and is, at the same time, a curiosity, from having two sorts of leaves; one set being submerged and presenting thread-like divisions spreading in all directions, another set float on the water and have three lobes. There are several species of aquatic crow-foots, and it is to this family (*Ranunculaceæ*) that the butter-cups, anemones, clematis, monkshood and lark-spurs belong. Another species *R. Purshii*, or yellow water crow-foot, is also common in this country.

The plants I have mentioned are the most common and best of the submerged class; but the following may be introduced, and are, many of them, recommended by Dr. Lankester for that purpose.

The Awl-wort (*Subularia aquatica*) which grows on the margin of ponds.

The Spiked Water-milfoil (*Myriophyllum spicatum*). This is found very commonly in deep water. There are six species of this genus.

The Marestail (*Hippuris vulgaris*) is not common in the United States, but is sometimes found growing in ponds and springs.

The beautiful Villarsia (*Villarsia nymphæoides*), which is so highly recommended by English writers for the fresh-water collection, is not found in this country.

The Buckbean (*Menyanthes trifoliata*) grows in bogs.

The Water-violet (*Hottonia inflata*) is found in pools and ditches pretty commonly.

The Water Speedwell (*Veronica palustris*) is obtained in this country, but not so commonly as,

The American Brooklime (*V. Americana*) while what

is known as the English brooklime (*V. Beccabunga*) is not found here at all.

The Water Soldier (*Stratiotes aloides*, Pl. III., Fig. 4) is common, and may be known from its resembling the top leaves of a pineapple growing beneath the water.

The Pond-weeds (*Potamogeton*) are excellent plants for the *Aquarium*. There are twelve species growing in this country; but neither of the two English species (*P. crispus* and *P. densus*) are found here.

IV. PLANTS FLOATING ON THE SURFACE.

The Duckweeds (*Lemnaceæ*) of which there are five species in this country, are all excellent plants for the *Aquarium*, as they not only aërate the water, but give that green shade which is so beneficial, and, indeed, to a certain extent, necessary to the well-being of the fish; and they also harbor, among and beneath their leaves, numerous microscopic animals, which serve as food for the fish. These plants consist of three, four or five rounded oval leaves, connected together, but which soon separate and float upon the surface of the water, looking as if they were the torn-off leaves of some other plant. When, however, these leaves are turned over, the under side will be found to be of a brownish purple color and have from one to five roots growing from the most pointed part down into the water, but never attached to the bottom or to any other plant. Their flowering is curious and interesting to watch in the spring, when one of the leaves will be found to bear the stamens, and another the pistil.

The American Frog-bit (*Limnobium spongia*) is the same as the European plant *Hydrocharis* and is found in the northern United States; it is said by English naturalists to be a good plant for the *Aquarium*. From not having been able, as yet, to find it, I cannot say whether it be or not.

There are many other plants which may be introduced into the *Aquarium;* but those I have given are the most common and easily obtained. I generally plant *Sagittaria* in the centre (removing it after a time, as it dies down, when the flowers go off), and place *Ceratophyllum* and *Nitella* around, whilst on the surface, I throw *Callitriche*, *Anacharis* and *Lemna*, the latter of which soon multiplies and covers the surface of the water. One of the prettiest arrangements in a fresh-water *Aquarium* is to have a good sized *Nitella*, with its light and transparent green stalks set off by a dark bunch of Hornwort placed as a background, for in an *Aquarium* as much taste may be shown in the grouping of the plants and animals, as in the arrangement of a picture; and nothing looks worse than to have the plants thrown in pell-mell, to take their own chance of arrangement.

CHAPTER VI.

THE FISH FOR THE FRESH-WATER AQUARIUM.

Proper period for introducing Fish—Small Fish preferable to large ones—What is a Fish?—Gold Carp a native of China—Gold-fish bred in Warm Water—Difference of Color—Minnows frozen in Ice—Deformities of Gold-fish—Feeding—Care required in Feeding—Minnow—Yellow Perch—Niagara Gudgeon—Sticklebacks—Dr. Lankester's Description of them—Sticklebacks not to be placed with other Fish—Mode of Building their Nests—Male Fish taking charge of the Eggs—Tenacity of Life of the Stickleback—New York species—Loach—Cat-fish—Carp—Prussian Carp—Pond Fish—Small Pond Fish—Pigmy Dace—Black-nosed Dace—Eels—Mode of eating Molluscs.

When our plants are growing, and our scavengers, the snails, doing their work properly; in fact, when they have got into order, then is the time to introduce our fish—and not before—or we shall be most likely to lose them. Fish being highly organized creatures, indeed the most highly organized of any that we intend to place in the tank, require that the water should be well aërated before they are introduced; and to insure this state of things, it is best to let it remain with its plants and mollusca for from three days to a week, and exposed to the sun's direct rays for several hours each day. This can be done with safety, as the snails will bear a temperature that would be uncomfortably high for fish or other tenderer animals. If we have three bright days in

succession in the week and our tank is exposed to the sun's rays for three hours each day near an open window, we may then, with safety, introduce the fish, whilst, in dull weather, it will require longer preparation.

Let it be always borne in mind, that the smaller the fish, the easier it will be to keep them properly and without trouble. Large fish, that is to say, fish of over five inches in length, are too large for any but a tank of four or five feet in length, and are more apt to die from the unnatural confinement than smaller ones. I have also found that small fish, after being caught, and before introduction into an *Aquarium*, will bear travelling any distance better than large ones.

Fish are known from living entirely in the water; hence, such animals as come out of the water at any time, for instance, frogs and lizards, cannot be termed fish, but belong to a class that has been named *Amphibia*. Fish are provided with organs of respiration, called gills, that obviate the necessity of their coming out of the water to perform the process of breathing; so that if, in an *Aquarium*, we observe the fish come to the surface to breathe, as gold-fish will when kept in a globe, we may be sure that something is wrong; either the animals are in too great number for the dimensions of the tank, or there is not sufficient vegetation to supply the oxygen for their sustenance.

The following are the fish that will be found most suitable for a fresh-water collection. I have tried many of them, and can recommend these:

The gold carp (*Cyprinus auratus*). is one of the hand-

somest fish for an *Aquarium*, and at the same time it is easy of domestication. This beautiful creature is a native of China, though common in this country. It is now to be caught in the Schuylkill River, just above Philadelphia, into which stream it has escaped from some pond, and increased greatly in numbers, size, and beauty—fish which breed in a semi-wild state always being of more brilliant color than those reared in confinement. The gold-fish was made a pet long before it was introduced into Europe: almost every Chinese mandarin having had a tank of them in his garden, where he could sit, smoke his pipe, and watch the gambols of the fish. The gold-fish, however, that are exposed for sale here and in Europe, do not, of course, come from China, but are bred for sale in tanks and mill-ponds; thus, in the north of England, they multiply in great numbers in mill-dams, the streams of which being supplied from or having flowing into them the refuse waters of many steam-engines, are at all times of tepid warmth, and, indeed, sometimes the temperature rises as high as 80° Fahrenheit. The fish in these waters are the most prolific, but not so long-lived as others. Difference of situation has been observed to affect the gold-fish in a remarkable degree; thus, in running streams, black spots make their appearance upon them; and in other situations, other as strange metamorphoses take place. The gold carp is not the only fish that can bear so high a temperature as 80°, for perch and mullet have been found by De Saussure in water heated to 89°, and live eels were found by the same naturalist in water heated as high as 113°. Many fish will bear sudden changes of temperature. I have had

minnows frozen in a block of solid ice, and after thawing them out, they have been as lively as if nothing unusual had happened; and I see Mr. Hibberd mentions a like fact. The color of the gold carp, as I have before said, varies greatly: thus, its natural color is golden orange with a white belly, but it is sometimes almost white, flesh-colored, grey, and even black; sometimes it is brown, or has its fins tipped with black, or one whole half of the animal is black —such varieties looking very beautiful in an *Aquarium*. This fish is peaceful and easily domesticated, whilst it will subsist on the smallest amount of food of any fish I have had. This fact highly recommends it to our consideration, as one of our collection. Sometimes the *dorsal* or the back fin is double, and the *caudal* or tail fin divided into three parts, so as to give the fish the appearance of having triple tails. When this latter circumstance occurs, Mr. Farrel has observed that they are deficient in *dorsal* fins. As to feeding gold-fish, many writers condemn bread as being deleterious, whilst Mr. Hibberd, a gentleman who seems to understand the management of an *Aquarium*, says: "There is no better food for gold-fish than the crumb of bread." And Dr. Lankester also observes: "Gold-fish may be fed on bread or biscuit." I, myself, acting on these suggestions, have fed them on bread, and found that they thrived wonderfully; and while so fed, I could not persuade them to partake of meat with the other fish—they would only take it into their mouths, and, after tasting, reject it; but if allowed no bread, and fed on meat alone, they would sicken, and even die.

Great care should be taken in feeding gold, as well as

other fish, for they are nearly as greedy as minnows, which gorge themselves until the food fills even their throats, and then will settle themselves down in some secluded corner of the tank to sleep it off, in the manner of a boa-constrictor after a feast.

The Minnow, Minny or striped Killiefish (*Fundulus fasciatus*), all of which names this fish bears, is also a very good inhabitant for the fresh-water tank, and will be described in the chapter on marine fish.

The American yellow Perch (*Perca flavescens*) is a beautiful fish, and is said to thrive in the confinement of an *Aquarium*. It is one of the best known and most widely distributed of all of our fluviatile fishes, and is closely allied to the *P. fluviatilis* of Europe.

The Niagara Gudgeon (*Gobio cataractæ*) is one of the class of fish bearing barbules, which are in this species very small, and, indeed, are to be observed with difficulty. It is found at the Falls of Niagara. The Gudgeon of Europe is so free a biter, that his name has become connected with a proverb. Unlike many of the fish that we could introduce into our tank, he does not grow large. The New York species never exceeds five inches in length. The Killiefish (*F. fasciatus*) is, in this state, called Gudgeon.

The Stickleback (*Gasterosteas*), four species of which are found in the State of New York, is recommended as an inhabitant of *Aquarium* tanks; but from not having had any great experience in them, I cannot describe their habits from personal observation, so the best thing I can do is to give the description of this fish that is presented to us by Dr. Lankester, a gentleman who understands perfectly

the subject on which he writes. He says: "I mention this little fish first, because I think he has claims to the rank of the king of fishes. Whether we regard his high organization, his courageous nature, his domestic habits, his varied instincts, his power of living in all waters, at all temperatures, he is fairly entitled to take the first place among fishes, and rank high in the animal scale. And where is this wonderful fish to be got? The nearest pool, pond or ditch that has life in it, is sure to have sticklebacks in it. Take a walk on the nearest road out of any country town, and the chances are that the first boy you meet with a blacking-bottle or a pickle-jar in his hand, has got sticklebacks in it. They are the first game of the youthful sportsman all over Great Britain. You need not catch them yourself; a penny will buy a score of them from any of these urchins. But should you wish to catch them for yourself—always a great pleasure, and an art to be cultivated—then a hand-net will take them by dozens; but this is a cowardly, wholesale way. If you wish for 'sport' at the same time, you will angle for them; not, however, with cruel hooks. The stickleback is much too brave and incautious a fellow to need a hook. A little red worm, at the end of a piece of twine, is all that is necessary to secure him. Once having seized the worm, he never lets go, though you drag him out of one element into another.

"When you have secured your stickleback, you must not inconsiderately place him with other fishes. I have asserted that he is a royal fish, and you will soon discover that he will bear no rivals. No sooner is he fairly

free in your *Aquavivarium* than he commences his reign—not always, I must confess, of the mildest sovereignty. The chances are, if you put him with fish of his own size, you will find them all dead in the morning. Sad spectacles! disembowelled by the use of our pet's spines upon his neighbor's stomachs—their eyes picked out as delicate morsels for his morning meal. This, therefore, must be a warning to you; and if you have but one jar, and wish to keep sticklebacks, you will probably not have an opportunity of keeping any other fish, of his own size at least.

"But he will repay you for his disposition. He has all the ways of other fishes, and many more besides. Look into your tank—see, there is one larger than the rest; he is clothed in a coat of mail, like a knight of old, and it is resplendent with purple and gold. See how his eyes glisten, and with every movement present a new color. He is a male fish, the king of your little shoal. He has important offices to perform. Presently, in the course of a few days, if you watch him, and are fortunate, you will see this wonderful little fish engaged in the most useful manner in building a nest. He first seizes hold of one little bit of weed, then of another, and carries them all to some safe corner, till at last his nest is built. Having done this, he gently allures his mate to their new-made home. Here she deposits her eggs, and having done this, resigns the care of them to our hero of the purple and gold, who watches over them with an anxiety that no other male in creation but the male stickleback seems to know. He fans and freshens the

water with his fins, and at last, when the young are hatched, watches over their attempts at swimming with the greatest anxiety. Nor is this habit confined to the fresh-water sticklebacks. A lady, writing to me from Aberdeen, and describing her *Aquavivarium*, says: 'A fifteen-spined stickleback (*Gasterosteas spinachia*) constructed a nest on a piece of rock, which was covered with a fine green sea-weed, and laced all together with a long thread, composed, apparently, of some secretion. The fish afterwards, for about the space of three weeks, watched the nest, never leaving it at all, save for the purpose of driving away other fish when they approached too near. When a stick was introduced into the vicinity of the nest, the fish would fly, open-mouthed, to attack it, and would bite it with great apparent fury. At the expiration of the above-named time, the young fry made their appearance by hundreds; but I am sorry to say they soon disappeared, being devoured by the other fish, and caught by the tentacles of the sea-anemones. The mother-fish continued her attendance at the nest as long as any of the young fry were left.'

"The stickleback is very tenacious of life, and will live out of water for several hours. I was watching, a few mornings since, on the sea-shore, where some fishermen had left the refuse of their nets the night before: all the animals were dead, except a solitary stickleback, who still survived, and on being placed in the sea, scuttled off again as though nothing had happened. The fresh-water species are often taken at sea at the mouth of rivers; and Sir Edward Belcher informs me that he took a

specimen whilst dredging at sea during the last Polar voyage."

Sticklebacks are not uncommon in the State of New York, some being found on the island upon which the city of New York is built; indeed, there is one species supposed to be peculiar to this State, and has therefore been called the New York Stickleback (*G. Neoboracensis*). The other species found in the same State are *G. biaculeatus*, or two-spined, *G. quadracus* (Pl. IV., Fig. 1) ,or five-spined, and *G. occidentalis*, or many-spined stickleback.

The Loach, Loche or Beardie (*Cobitis barbatula*), is a small fish, and is said to do well in confinement. It belongs to the same class of fish as the Gudgeon—which has followed the moustache movement, having barbules around the mouth. Fish having these appendages are said to feed at the bottom of rivers and lakes. Loach, like most of the fish that we make use of for the *Aquarium*, live on larvæ and small worms, which can be supplied to them during the summer, but in winter they must be satisfied with such food as they can get. The Loach is not, however, found in the State of New York, but is here represented by the Cat-fish, which also has the barbules attached to its mouth. There are several species, but the best for the *Aquarium*, on account of its size, is the black Cat-fish (*Pimelodus atrarius*) which is found in Wappinger's Creek, a tributary of the Hudson, in Dutchess county, and is about four and a half inches in length.

The Carp *(Cyprinis carpio)* is a native of Southern Europe, and it is said to be suited to the *Aquarium*, as it frequents ponds and still water. A fish which lives in

quick running streams will, of course, not be likely to succeed in the quiet of an *Aquarium;* therefore the trout, which would be a beautiful creature for a tank, cannot be introduced.

The Prussian Carp *(Cyprinus Gibelis)* is recommended by English writers, but it is not, I believe, found in America.

The common Pond-fish *(Pomotis vulgaris,* Pl. IV., Fig. 2) is beautiful and excellent for the fresh-water *Aquarium,* as he is easily rendered tame and looks well in a tank, being a slow mover, easily caught, and swimming majestically about; the sun, when shining upon his sides, presenting us with a gorgeous spectacle, and from which circumstance he has received the name of Sun-fish. The pectoral fins are beautiful objects, as they are moved slowly about when he stays to gaze on us, with his large eyes, in seeming astonishment. He has a black spot, just beyond his gills, which is tipped with a beautiful bright scarlet His most popular name (and which he deserves) is Sun-fish, but he is also called Pumpkin-seed, an appellation that is not quite so aristocratic, and is applied to him on account of the many spots on his side. In the State of Massachusetts, this fish is called Bream.

We have another species of *Pomotis* in the State of New York, the black-eared Pond-fish *(P. appendix),* which is destitute of the scarlet spot on the opercle, but is a little more tender than the last named species.

The Pigmy Dace *(Leuciscus pigmæus)* is a pretty little fish, being only one inch long, and is found in brooks near Tappan, Rockland county, New York, where it was pro-

cured by Mr. J. G. Bell. It will flourish in an *Aquarium.* But the best of this genus for the fresh-water collection is the black-nosed dace *(L. atronasus).* The body of this little fish is of a greenish color above, and the abdomen silvery. A broad dark brown or blackish band passes from the nose, down each side, including the lower half of the eyes. This band proceeds, in a straight line, to the tail. On the head, behind and above the eyes, is a brown mark, in the form of a heart, the point towards the tail. The brown stripe on the fish, which passes over the nose, gives him a comical appearance on being viewed from the front. It is an abundant fish in this and adjoining States, in fresh-water streams and rivulets. It is easily kept and tamed. I have some that are extremely tame, and who, when I tap on the glass, come to the side of the tank that I may happen to be at, and, if I allow them, will nibble at my finger. They do not, however, like the minnow, jump out of the water when I present my finger to them, but readily take food from my hand, and seem to like being stroked gently, turning quickly around, as if in astonishment, but hardly ever attempting to escape. They never exceed the length of three inches; those I have are two inches long. The scales of this fish are very small, giving it a sleek, glossy appearance.

Eels have also been recommended for the fresh-water tank, as their peculiar mode of swimming contrasts well with that of the other fish; but I have found that even such small ones as are not more than two inches in length have an unpleasant habit of making away with our

useful little snails. They exhibit a curious mode of tearing off a piece from the molluces, which shows that they cannot have very sharp teeth. They will seize on a portion of the foot, for instance, which is projecting beyond the shell, and, making themselves perfectly rigid and perpendicular to the bottom of the tank, spin around with about the velocity of one hundred revolutions per minute, until they have wedged the snail between two stones, when the portion is torn off, and the eel, like his near relation of the land, the boa-constrictor, will lay himself at length at the bottom of the tank until the morsel has passed into his capacious stomach, when he will again attack the snail—although he will rather choose another living specimen, thus seeming to destroy them from pure spite, and in revenge for his confinement, leaving their carcasses to decay and upset the economy of our well balanced collection. It is for this reason I assert that they are unfit for the fresh-water *Aquarium.*

CHAPTER VII.

MOLLUSCA, CRUSTACEA AND REPTILIA FOR THE FRESH-WATER AQUARIUM.

Use of Mollusca—Greatest Variety of Mollusca to be looked for in the Ocean—Univalves and Bivalves—Lymnea columella—Lymnea fragilis—Physa heterostropha—"Walking on the Air,"—Eggs of Physa—Production of Young—Right-handed and left-handed Shells—Physa plicata—Planorbis bicarinatus—P. lentus—P. armigerus—P. corpulentus—P. exacutus—P. parvus—Paludina decisa—Melania—Unio complanatus—U. radiatus—Anodon fluviatilis—Craw-fish—Fresh-water Shrimps—Asellus communis—Branchipus stagnalis—Cyclops quadricornis—Bull-frog—Croak of the Frog—Transformations of the Frog—Spring Frog—Marsh Frog—Water Lizard—Red Salamander.

It will be remembered how, when speaking of the principles of the *Aquarium*, it was said that a green scum would, after a time, form on the glass sides and so obscure our view of the interior; now, for the purpose of removing this so that a clear and unobstructed sight of the habits and actions of our pets can be procured, we follow the experienced example given us by Mr. Warrington, and place in our *Aquarium* Nature's scavengers, the little fresh-water snails. In a fresh-water tank the Mollusca are represented only by these pretty little creatures, for though many writers on the subject have asserted that they are necessary evils, the sight of which is only to be borne because of their usefulness in rendering and keeping

it clean, yet I assert that though they may not be among the most active of the creatures that we place in our tank, still for the beauty of the forms of their shells, if not from their curious mode of progression over the glass, and floating along the surface of the water, as well as for the purpose of watching them bring up their broods of minute snails, which, in time, serve as food for our fish, they are to be viewed not merely as "necessary evils," but as good, interesting, and pretty citizens of our world in miniature.

The greatest in quantity and beauty among the Mollusca are undoubtedly those dwelling in the sea; but some are inhabitants of fresh water, as the familiar water-snail that we find in the mill-dams and ponds, whilst others inhabit the land, as the common garden slug. The Mollusca form a class of animals that bear shells on their backs and whose coverings we pick up along the beach, and which constitute some of the first objects of natural history that we learn to admire for their beauty of form and the varied tints that they present. The shells of different genera of Mollusca are of varied form and texture; thus, those of the salt-water Mollusca are, in general, hard and strong, whilst the shells of the fresh-water snails are thin and more of the consistence of horn than what we understand as shells. There are some of the mollusca, however, that seemingly do not present us with any shells at all, as the garden-slug; but they have shells, though they are small and hidden in the substance of their bodies and do not serve as a means of defence, as those of the well known oyster or clam do to them.

Mollusca must be looked for, as we have before suggested, in greater quantity and beauty in the ocean than in fresh-water lakes and rivers. The marine shells also present us with a greater variety in form than our fresh-water friends, but many of those that we find in fresh-water streams and milldams are of great beauty and grace. The pretty coil shell *Planorbis*, the *Lymnea*, *Physa*, *Paludina*, *Malania* and fresh-water muscles, as they are called, the *Unios*, and *Anodons* all look well and are extremely useful in a fresh-water tank, as removers of the troublesome decaying matter.

The Mollusca, or shell fish, are divided into two great groups: the *univalves*, or those having the shell formed in one piece; and, the *bivalves*, or those having the shell consisting of two portions united together at some one point by a *hinge*.

Of the first class, we have several that may be introduced with advantage into our tank; and first among them comes the genus *Lymnea*, of which there are fifteen species found in the State of New York, some of them being very common.

Lymnea columella (Pl. V., Fig. 1). I have found this species very common in several places. It is an ovate, fragile shell, varying from one half to one inch in length, though it is generally found smaller than that. The spire is narrow, acute and much shortened at the aperture. Aperture very large, more or less expanded, and having a thin film of enamel at the lip. This lip is also so much arched as to display a considerable portion of the interior of the shell, which distinguishes it from any other of the

New York species. The color is a pale greenish or straw yellow. It was when keeping this species that I first became acquainted with the mode of growth of the young from the egg to maturity. The process I will describe when we come to speak of the *Physa heterostropha.*

Lymnea fragilis (Pl. V., Fig. 4) is another species of this genus that I have introduced with advantage into my fresh-water tank, and is perhaps a more graceful shell in form than the last mentioned. It is darker in color than the *L. columella,* but is not so large a shell, being only from six to nine-tenths of an inch in length. It is the same as the *L. fragilis* of Europe, and is common in this State. The reader, in his rambles, no doubt will come upon many other species of this genus, all of which may be used for the fresh-water tank. The commonest, however, in the southern part of the State of New York, are the above and *L. desidiosa.*

The genus *Physa,* which are left-handed shells—that is to say, when the opening is held towards us, it is on the left hand of the apex, whilst in the genus *Lymnea* it is on the right hand—are represented in New York State by eleven species.

Physa heterostropha (Pl. V., Fig. 5) is a very common species, found in almost every pond and stream. It is of a yellowish or greenish-yellow color, and becoming more dusky with age. It has the inside of its lip of a dull reddish color. This animal, as well as the *Lymnea,* is often seen floating, with its shell downwards, upon the surface of the water, literally, as a writer has observed, "walking on the surface of the air," and moving along by means,

as it would seem, of the motion of numerous *cilia*, or minute hairs attached to the under surface of the body, making what is called the foot. This mode of progression can be seen better in an *Aquarium* than in a pond or stream, for they seem to be more addicted to it in confinement than in their natural habitat—whether because of the absence of breezes ruffling the surface or not, I cannot say. This animal lays its eggs in clusters of from fifteen to sixty, contained unsymmetrically in a transparent sac, whilst the *L. columella* attaches its eggs in groups of about a dozen, arranged in rows around the stalk of some water-plant, and also contained in a transparent investing membrane. If these eggs are examined under a magnifying glass, we shall see that they have a small yellow spot in some part of them: this is the yolk; after a time we shall see that this spot increases in size, and assumes more and more the form of the parent animal. At the same time, the young snail, having a slight shell investing it, begins to rotate about in its egg-shell, until at last, when it is perfectly formed, it breaks through one end of the shell and makes its escape a perfect animal, and at once takes upon itself the habits of its parents. I have had hundreds of these juveniles floating, shell downwards, upon the surface of the water of a tank that I kept on purpose for rearing them in (for if we attempt to do so in an *Aquarium*, the eggs, as well as the young snails, will be rapidly eaten by the fish; and in this way, if we keep enough snails, we can feed our fish with food that they relish). The movement of the ovum in the egg is always, in the case of the right-handed shells, from right to left,

and *vice versâ*. This motion has been supposed by some writers to influence the form of the shell, and most likely it is so. When the young snail is examined under the microscope, just before it bursts the egg, we can see through its thin papery shell, and observe the beating of its little heart. The increase in our stock of snails that we may expect, can be imagined, when I state that one of these animals will deposit from two to three of the sacs of eggs a week, thus producing, in the course of six weeks or two months, from 900 to 1,000 young. There are other species of *Physa* found near New York, one of which, *P. plicata*, is obtained from the island on which the city stands.

The genus *Planorbis*, or coil-shell, is represented in New York State by fourteen species, several of which are common: for instance, *P. trivolvis*, which I have obtained from Oswego Lake. It is said to be abundant in many ponds and streams.

Planorbis bicarinatus (Pl. V., Fig. 3) is one of the prettiest species of this genus. It has its three whorls depressed on each side, and is, in appearance, a solid, squared shell. All the *Planorbi* are fonder of the *confervæ* than of the larger plants, and are, therefore, excellent inhabitants for the fresh-water tank, whilst the *Lymnea*, most of them, are too dainty to eat up the troublesome minute plants, but will be sure to make away with your tenderer vegetables, as *Potamogeton*. The other common species of the genus *Planorbis* in New York State are, *P. lentus*, *P. armigerus*, which, with *P. corpulentus*, are right-handed, whilst the other species *P. exacutus*, *P. parvus*, are left-handed shells

The genus *Paludina* is also a helical shell, but more conical than the last genus, and bears a little resemblance to a stout *Lymnea*. There are only three species found in our State; but I have some in my tank that came from the Delaware River, which are slow animals, but from being large and light in color, they form a good contrast to the *Lymneæ* and *Planorbi*.

Paludina decisa (Pl. V., Fig. 2) is the commonest of the New York species.

The shells of the genus *Melania* form a good contrast in appearance to the other fresh-water shells, being elongated cones. They are, however, unfortunately mostly confined to the Southern and Western States, and are not found in Europe except in fossil state. They are slow creatures in their motions, but are good grazers.

Of the bivalve shells we have the genus *Unio*, or fresh-water mussel, as it is called, which may be introduced into our *Aquarium*. There are quantities of species of this genus in this country, and many of them are very common, as *U. complanatus* and *U. radiatus*. There are twelve other species found in this State. They are not, however, lively creatures, and are of no use in cleaning the glass.

There are ten species of the genus *Anodon* found in this State (of New York), one of which, *A. fluviatilis*, is very common.

The *Crustacea* next demand our attention, and are also fair scavengers, and more lively in the performance of their duties than their fellow-workmen, the Molluscs. They do not, however, clean the glass, but only sift, as it were, the decomposing matter out of the water. Yet even if

they were no more scavengers than the fish, we would still introduce them into our collection, because of their strange forms and habits.

The little Craw-fish, or fresh-water Lobster (*Astacus Bartonii*), is a curious creature, and resembles the common lobster in everything but dimensions, as it is rarely over three inches in length. It is said to be exceedingly common in the mountain streams of this and the adjoining States. It is shy in daylight, concealing itself under stones until night, when it comes out. The American craw-fish is rarely eaten, whilst the English species, *A. fluviatilis*, is considered a delicacy, and sold in considerable quantities in the London markets. Dr. Lankester mentions that he has never been able to keep it alive in confinement, whilst Dr. Ball, of Dublin, kept one so for two years. I have never myself tried to keep them, but suppose, with a little care, it may be accomplished.

The fresh-water Shrimp (*Gammarus minus*), is common in most of our fresh-water streams, and may be found by searching under stones and pieces of wood. It is extremely active, and if it could be kept alive, would make an interesting inhabitant of an *Aquarium*. It is small in size, being about one-third of an inch long, and resembles the little sand-flea that we find under stones on the sea-shore.

There is a small creature, the *Asellus communis*, that is found in nearly every stream and often brought up in great quantities by dragging the net along the bottom. It looks somewhat like a larva of some insect, and is extremely lively. I have found it easy to keep in an *Aquarium*, although it is small, being only from a quarter to a half of an inch in length.

In fresh water are also found two more little creatures allied to the shrimp ; one, the *Branchipus stagnalis*, is found, as its name indicates, in stagnant pools, and the other, *Cyclops quadricornis*, is found also in similar water and is excellent food for fish. Many others of these microscopic animals, some of them crustaceous, are found in fresh water and may be introduced for the purpose of studying their habits.

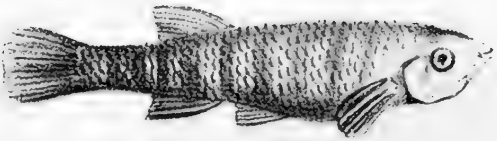
The reptiles come next in our list, and we shall begin with the consideration of the frog, whose young, the tadpoles, are such useful servants in our *Aquarium*.

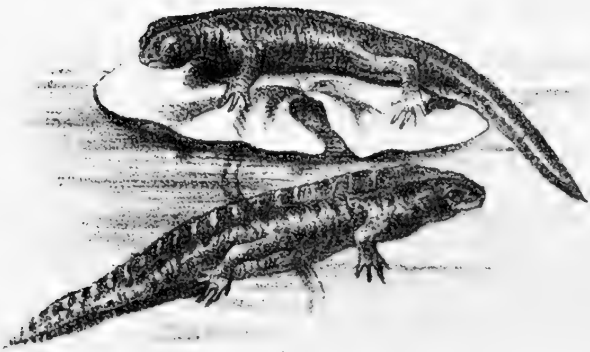
The Bull-frog *(Rana pipiens)* is the common frog of our ponds, and it is the tadpole of this species that we see in such large quantities in ponds and brooks. Dr. De Kay speaks of it as follows: "The Bull-frog is one of the largest of the family in this State, and appears to be generally distributed throughout the Union. It is well-known by its hoarse voice, compared by many to the roaring of a bull, and which is so loud as to be heard at a great distance; it is aquatic, although it occasionally comes to land. In the adult state it feeds on insects, crawfish, helices and small fish. The tadpole (Pl. V., Fig. 6), on the other hand, appears to be exclusively herbivorous." The changes that the Bull-frog undergoes in its transition from the egg to the perfect animal, are curious and will well repay a careful examination; but it is generally in the tadpole state that we procure our *amphibia*, and from that state to the one of the frog we can observe the transitions. The tadpole has gills, or rather only one, on one side of his head,

where we may observe, just behind the eyes, a round opening, through which the water is forced; but, though he is furnished, like fish, with gills, they seem to be imperfect, for sometimes he must come to the surface to breathe, and does so in a strange wriggling manner, somewhat like an eel. Though the "tads" are herbivorous, they will eat animal matter, and, indeed, even their own kindred. After a time, the creature increases in size, the hinder part of the body swells, and at last, the budding of the hind legs, which are always the first to appear, may be distinctly seen. When these are perfect the other pair make their appearance in the same way, though sometimes I have observed that if the "tad" is carried any distance and roughly treated, the hind and also the fore legs will often spring through the skin in one night, and then we have a curious lizard-like animal. As soon as he has got his legs, the gills disappear, and the tail gradually dwindles away, its substance going to build up the body. When this is gone, we must take care, or our frog will also be gone, as he now fancies the land as much as the water, and will crawl up the corner of the tank and so make his escape, unless we cover it, a good way of doing which is to stretch a piece of gauze on a frame and lay it over the top. The poor frog seems to have been created for the experiments of the philosopher, for it is he that has to take all the new poisons, that we may observe their effects; it is he that has to suffer what Dr. Hall terms "Strychnizm;" it is he that serves as a galvanic battery, and it is in his leg or tongue that the circulation of the blood is exhibited under the microscope to

the admiring observer. The Bullfrog sometimes attains the length of twelve inches, though the common size is from four to six. It is not this species, but another, the Spring Frog *(Rana fontinalis)*, that is eaten as a delicacy, and, unlike the Bullfrog, it is herbivorous. If we intend to keep frogs at all in our *Aquarium*, we shall find the prettiest, especially in its young state, to be the Marsh Frog *(Rana palustris)*. It is also called the tiger, leopard or pickerel frog.

The Water Lizard *(Triton millepunctatus)*, crimson-spotted Triton or Eft, is found all over the State of New York, especially in mountain brooks and lakes, and is capable of withstanding a very low temperature, as it has been observed under ice an inch thick. The female is entirely smooth, and the male, in breeding seasons, is furnished with a brilliant coat, and wears a crest upon his back, as is seen in Pl. VI., Fig. 2. This crest disappears later in the season. The newts are intelligent animals; indeed, more so than fish, and are easily tamed. There are several other species found in this State, but the above is the most common. When we intend to keep these creatures, it will be found best to have a portion of rockwork projecting above the surface of the water, so that they may get out into the air, as they are fond of doing. Another common New York species, the *Salamandra rubra* of naturalists, may be introduced into an *Aquarium* with advantage, as it is only about five inches long and of a bright crimson, spotted with black. Its color, which very much resembles that of the gold-fish, contrasts well with the darker species and the green vegetation.





CHAPTER VIII.

GENERAL MANAGEMENT OF THE FRESH-WATER AQUARIUM.

The Tank to be well Seasoned—Feeding Fish—Bread to be given to Gold-fish—Taming Fish—Care to be taken not to introduce too much Food—Cheese for Fish—Accumulation of Confervæ—Removal with a Sponge—Emptying the Tank—Grouping—Sun-fish a Peaceful Inhabitant—Sun-fish nibbling Minnows' Tails—The Tailless Minnow—Varieties of Snails—Fish coming to the Surface to breathe a Bad Sign—Aërating the Water—Definition of an Aquarium—Temperature of the Water—Shading the Tank from the Sun—Air blowing on the Surface of the Water advantageous—Dead and Sick Animals to be removed—Diseases of Fish.

It will be as well, on concluding the portion of this book devoted to the fresh-water *Aquarium*, to give a few pages that may be useful, not only to beginners, but which will, I hope, also aid others who have had tanks in operation for some time in the keeping of them, and to whom some slight, unforeseen accident may happen that, from having never occurred before, may endanger the loss of the whole stock; for them, no less than for beginners, I have put together the results of over two years' experience in the management of *Aquaria*, especially as regards fresh-water.

To begin at the beginning, *first*, be sure that your tank is well seasoned, and that the cement used in its construction contains no lime or lead; as the use of either of those substances will endanger the lives of your pets. Be sure

at the same time that the tank is perfectly clean, before you put any stock in. This is a point often neglected, and even if the soiling matter be not dangerous to the lives of the fish, it will render the view of the interior obscure and make the tank look untidy. When the *aquarium* is stocked according to the directions given in the previous chapters, we must not suppose that our work is finished, and that we may sit down and leave our collection to take care of itself, for there are certain points that must be always attended to, such as feeding the fish, sickness of animals, etc.

Feeding Fish.—Generally speaking, any kind of meat may be given to them, if it be torn up into small shreds, resembling worms, so that they can easily swallow it, for fish do not masticate their food. I have been used to give mine chicken, as it is tender; but beef seems to suit them best as a general diet. Some writers condemn bread as dangerous; but I have, generally, not been able to make any but gold-fish eat it, and they seem to thrive on such food. After a time, you will find that your pets will have become so tame as to eat from out of your hand. Minnows will be the first to show this seeming intelligence. Dace and sun-fish next, and after them gold-fish. I have some minnows that come to the surface and nibble my finger when I place it just below the water, and allow me to stroke them gently, especially before feeding, and when they expect their meal. These fish will often follow their owner around the tank, much after the manner of animals in a menagerie about feeding time. We should always be careful not to introduce too much food into the tank at once, as, what is not eaten will decay and foul the water; and

for that reason it is always best not to give the fish all that they will take, but rather keep them on short commons, as I have observed minnows and sun-fish to stuff themselves with food until it projected from their mouths and then, afterwards, eject it and allow it to decay in some out of the way place, where we would not be likely to see it until it was too late and damage had been done. Mr. Hibberd recommends cheese as good for fish. I have found that sun-fish eat it, but only when very hungry.

The snails will often do their work insufficiently, and then the glass will become cloudy with *confervæ*. To remove this, I use a piece of sponge tied to the end of a

Sponge.

stick, and rub it across the glass. Some writers mention an old nail-brush as answering the same purpose, but it cannot be introduced and used so easily as the sponge. With all our care, no doubt, it will be found almost necessary to empty the tank once a year and thoroughly clean it; but, still, this should never be done, unless the soil at the bottom has become black and the plants show signs of decay; then, only, we should remove our live stock by means of a net, made by stretching a bag of bobbinet over a wire ring and carefully placing them in a vessel of clean water until the cleaning of the tank is complete. The plants are, then, also removed, as are the water and soil. It will be found preferable not to use the same soil again, as, with all our labor, it will be found very difficult to per-

fectly clean it. The bottom and sides of the tank should be scrubbed with a piece of flannel and soap; and if the bottom be stone, sand may also be used with advantage. When the tank is perfectly clean, we can again introduce our stock, arranging it as has been recommended in former chapters.

Grouping.—This is a point that is of very great importance, and, therefore, must not be neglected; for, if we throw in our stock indiscriminately, we shall find that many of the stronger will prey on the weaker, and thus we shall have constant warfare going on among those which should form a "happy family." Thus our friend, the Pike, though a very curious fish, and one whose habits it would be interesting to watch, cannot be placed in company with many other kinds of fish, as he will very soon make away with them, and if we intend to keep him, it must be alone, where he will remain sulky at the bottom of the water, until we deign to notice him by feeding.

The same remark holds good concerning the stickleback, who will attack other fish many times his own size. In a tank of ordinary dimensions, that is to say, of eight gallons, which is the capacity that I generally use, I would place as vegetation, *Stratiotis*, *Ceratophylum*, *Calitriche*, *Anacharis*, *Chara* and *Lemna*. Then, for animals, we can have our universal inhabitants of the fresh-water *Aquarium*—the gold-fish of about three inches in length, sun-fish of the same size or larger, for I have kept large sun with small gold-fish, and have never found them to disagree, although I have heard some persons assert that they will. The sun-fish is a slow and stupid fish in his actions, but makes a beautiful denizen

of our tank, where his many-colored sides glisten in the sun like a rainbow. Small minnows cannot be kept with sun-fish, as those gentlemen, when they are hungry, are rather fond of nibbling at minny's tail, thus damaging his beauty as an ornamental fish, and making it rather tiresome for him to get along until his tail grows again. I once had a little minnow (about an inch and a half long) who had his tail entirely bitten off by shrimps and crabs, and could not swim with the speed and grace of his fellows. He, poor fellow, had to wag the entire hind part of his body, and use it as a screw propeller in lieu of a tail. I must say, however, that I think he deserved the treatment he got, for he was an extremely pugnacious little chap, and would attack my crabs for the purpose of stealing their food, when larger fish would hold back in fear. After about two months, his tail grew out finely again; but he had accustomed himself so to swim without the help of that appendage, that, to the present day, he propels himself by wagging one entire half of his body. Sticklebacks are not safe creatures in a tank with small fish, or even with minnows, but with large ones, say, of three inches in length, they will do well enough. A few lizards and tadpoles can be introduced, and will be found to be excellent servants in keeping the tank clean and the glass bright; snails, of course, must be used (as I have before mentioned) and we can, in the choice of them, suit our own taste and fancy.

The round and graceful *Lymnea* and *Physa*, or the *Ammonite*-formed *Planorbis*, the bulky *Paludina* and the long cone-shaped *Melania*, may all be introduced as we can procure them; and some of these species, especially the *Lymnea*, are

extremely common. I have also put in a dozen or two of the curious little fresh-water shrimp, *Asellus communis*, which is extremely common in some of our streams. They make excellent scavengers and are lively little creatures besides, but do not live long in confinement, either being eaten by the fish or otherwise disappearing.

Sometimes you will perceive that your fish come frequently to the surface to breathe or remain there. When this happens, we may be certain that something is wrong in the economy of the collection. This often indicates that the inhabitants are not supplied with enough oxygen for support, and may be caused, first, by crowding the fish, when some of them must be removed to another vessel, or the water must be aërated; and to effect this, I have used a contrivance which I will describe in chapter fourteen. Secondly, it may result from there not being enough vegetation in the tank; and this is a point that can only be arrived at by direct experiment. Some writers will tell you that one plant is sufficient for two fish, but they do not say how large the plant is to be. But the fact of the fish coming to the surface may be caused by some decaying matter in the tank, either animal or vegetable, that renders the water foul and unfit for the inhabitance of animals and must be at once removed.

It should be remembered, when it is found necessary to aërate the water, that we do not possess an *Aquarium:* which is *a collection of plants and animals that is self-supporting, self-renovating*—that requires only the feeding of the inhabitants and the watching for accidents.

The temperature at which the water in the *Aquarium*

should be kept is, also, a matter of great importance, for if we once allow it to get too low, the water freezes, our vessel bursts and then farewell to all our pets; and if we allow it to get too warm we shall lose both plants and animals by a system of slow boiling. Sixty degrees of Fahrenheit's scale is about as high as we should allow the temperature to rise. In summer, we should, therefore, shade the tank most part of the day from the direct rays of the sun by means of ground glass or a white window blind or oiled paper. And in winter, if we have it in a room where there is a blazing coal fire, or, worse still both for man and beast, a heater of a furnace, we shall find that though the warmth may be pleasant to us, it will be decidedly uncomfortable for our fish, who are not used to being shut up in houses. To remedy this we can place it near the window, which will, most likely, be the coolest part of the room, or even open the window. A little fresh air blowing on the surface of the water, if it be not too cold, is good at all seasons for both plants and animals. I generally keep a thermometer immersed in the water of my tank, by means of which I can judge of the temperature and tell when I should minister to the well-being of my fish. Mr. Hibberd recommends in summer, when the water of the tank has become unduly heated by the sun's rays, to wrap around it a coarse cloth, saturated with water, and to keep this wet from time to time.

Remember, that dead and sick animals should be removed as soon as discovered. Fish are apt to become diseased in winter and are troublesome to cure. Sometimes the caudal

fin will become coated with a fungoid growth. It should be removed at once with a fine pair of scissors. It usually grows again very soon. Gold-fish are subject to a disease that is termed by dealers "the slime," and to cure this, it is best to remove them from the tank and place them in a pail full of fresh water and then throw over them a handful of silver-sand, so that it may fall on the skin of the fish. It will cause them to rub themselves, and entirely eradicate the slime without injuring the fish. I have lost a great many gold-fish from this and other diseases. When fish appear dull and stupid from no apparent cause, I have found that it often enlivens them to put them in a pail, and setting it under a croton-water tap, allow the water to run on them for about a quarter of an hour. Minnows are subject to a disease during the winter, which causes them to turn light colored and float on the surface of the water panting, whilst other fish in the same tank thrive. For this disease I have found no cure, and have remarked that it seems to attack them oftener in fresh than in salt water.

CHAPTER IX.

THE MARINE AQUARIUM.

Marine and Fresh-water Tanks contrasted—Advantage of Flat-sided Vessels for Marine Aquaria—Rock-pools—Bottom of the Tank—Shell bottom—Rockwork to project above the Surface of the Water for the Fiddler Crabs—Introduction of Vegetation—Water—Washing Plants—Procuring Sea Water—Cask for holding it—Artificial Sea-Water—Its Manufacture—Seasoning the Water.

As the laws of nature are fixed and unchangeable, and as they govern the plants and animals living in the ocean as well as those that dwell in ponds and rivers, a marine *Aquarium* has of course to be established on the same principles as a fresh-water one. The management of the two different kinds of *Aquaria* will, also to a certain extent, be similar. The only great difference between them consists in the appearance presented by each when fully stocked, for, though the fish may appear similar, the other animals and the plants will be entirely different. They that "go down to the sea" have stranger tales to tell of its wonders than they who explore the lake, pond or river. In the fresh-water collection we have not the many-tinted anemones, the brilliant serpulæ, and, then, the crustacea are, in such a tank, restricted to a few species that are difficult to keep alive in confinement; whilst, in the marine *Aquarium*, we have the

funny hermit crabs (two species), lobsters and shrimps, while the salt-water fish are more varied in form and color than those found in ponds and rivers.

The vessels in both cases are, of course, the same, except as to Mr. Warrington's tank, which is made especially for use as a marine *Aquarium*. And Mr. Hibberd very truly says, "It is also important to bear in mind that marine stock invites the use of the microscope in a greater degree than river specimens, and a flat-sided vessel is the only one which affords proper facilities for the application of a magnifier to its contents." The water, also, in a marine tank does not need to be so deep as that in a fresh-water one, that is to say, all of our stock, anemones etc., except fish, will thrive just as well in a shallow vessel as in a deeper one; and as we intend to imitate the little pools left in the rock by the receding tide, we can have for that purpose the circular glass pans used for milk in dairies. Still, if we intend to keep fish of any size, we must have a deeper vessel—and an oblong tank, holding about eight or ten gallons, will be found the best, for though circular vessels will answer pretty well for fresh-water *Aquaria*, marine stock does not look well in them.

The bottom of our marine tank can be made of the same material as that used for a fresh-water one, but will not need to be made so carefully, as we are not going to plant our vegetation in it, and shall not, therefore, require fine sand below and pebbles above; and it can be made entirely of pebbles or shells. The little golden and pink shells that we pick up in profusion all

along our shores, and which belong to the genus *Anomia*, make an excellent bottom. They, of course, as well as any other shells or pebbles that we intend to use as a bottom, should be carefully washed—not for the purpose of removing the salt, for that would do no harm in a marine as it will in a fresh-water collection, but in order to get rid of any decomposing animal or vegetable matter that might be adhering to them, and which would foul the water; and if we do not attend to this, we shall be apt to introduce sponges, zoöphytes and algæ, dead or dying, which would, of course, be dangerous inhabitants.

We must also remove all sponges and other minute growths from pebbles, shells, rocks or other matters that we are going to place in our tank, as they are all dangerous, being apt to die and decay before their demise is discovered.

Rockwork should be introduced sparingly into a marine tank; but pieces of rock, bearing sea-weeds, can be piled up in one corner with advantage, as it affords a point —when projecting above the water—where such animals as wish to do so can come out occasionally into the air. The little fiddler crab (*Gelasimas vocans*) is one of these, as we shall find if we throw him into the water from his native shore. On our doing so, he will immediately return and attempt to find his burrow in the wet sand, and even in a tank that has no rockwork projecting above the surface of the water I have noticed this crab get upon the highest point and look upwards, as if wishing, with an honorable ambition, to strive at greater things. If we

keep fiddler crabs in our tank, it will be as well to have some part of the bottom formed of sand, so that they may burrow if they wish.

When we have got the bottom and rockwork arranged according to our taste, we introduce plants which serve the same purpose in the marine collection as in the fresh-water tank—that of supplying the animals with the oxygen for their respiration—and these we procure along the sea-shore. On sandy shores, we shall find the green algæ attached to small stones partly buried in the sand or rolling about loose as moved by the waves; these, if not too large, will do excellently for rockwork, in our miniature ocean, and they present us with the advantage of plants growing on our ornamental rockwork which add much to its picturesque appearance, and so we do not encumber our tank with useless stones, but in this way make use of every inch of room we can to bear our life-giving vegetation. The red and purple sea-weeds will be found on rocky shores, together with some of the green, one of which, the *Bryopsis pulmosa*, makes a beautiful ornament when introduced with taste into elevated positions.

The water comes next after we have put in our plants. And here I should mention that I have found it preferable to wash the green algæ (as *Ulva* and *Enteromorpha*) for about half a minute in fresh and not in salt water, as the fresh water kills many minute animals that would otherwise be apt to die afterwards and foul the water. I generally shake the stones which bear the plants of *Ulva* and *Enteromorpha* rather roughly in the fresh water

for a little time, thus removing many torn portions of fronds that, if not absolutely injurious, are unseemly in a well-arranged tank.

The water can be procured direct from the sea-shore, and should be taken when the tide is high. It can, with ease, be obtained by inhabitants of the city of New York from the East River, about a mile or so above the city at Hurlgate, or by sending a barrel down the bay on one of the steamboats that ply to and from Staten Island. The cask or barrel that we place it in for removal should be perfectly clean; and, for this reason, it is best to use a new one that has been often and well washed out so as to remove all dust and other matters. Mr. Gosse condemns oak barrels as apt to impart deleterious substances to the water; but I have never found it so, and think it must only be when the water travels in the cask a considerable distance. For my own part, I have often been unable to make real sea water succeed to my entire satisfaction, and many of my friends have complained of the same thing. It seems, that genuine sea water contains seeds of algæ and decomposing animal and vegetable matter which, after a time, will generally upset the economy of our tank, and I have often not been able to make it succeed for a longer time than sixteen days, after which it would turn foul. I have now a tank, however, containing real sea water which has been in vigorous operation for about two months, and is in so flourishing a condition that all the stones are covered with young algæ and snails have been depositing their eggs in the grottoes of my miniature ocean.

Many persons who reside at the sea-side, or even those who live in a city, can send once or twice in a fortnight for sea water, and in this way keep their stock alive; but we must remember that it is not then an *Aquarium:* as the water needs changing.

Finding that sea water was apt to putrefy, Mr. Gosse reasoned thus: "Why was it not possible to manufacture sea water that will answer the same purpose as the genuine article as procured from the ocean itself?" and taking as his guide the composition of sea water as revealed to us from the analysis of celebrated chemists, which is as follows:

Water	96.4744
Common salt or Chloride of Sodium	2.7059
Chloride of Magnesium	.3666
Chloride of Potassium	.0765
Bromide of Magnesium	.0029
Sulphate of Magnesia or Epsom salts	.2295
Sulphate of Lime or Gypsum	.1407
Carbonate of Lime	.0033
Loss not accounted for	.0002

he manufactured some; and communicated the results to the "Magazine of Natural History" in July 1854. In making the artificial sea water, Mr. Gosse left the salts of Lime and the Bromide of Magnesium entirely out of the question, as they occurred only in very small quantities and he found that water, formed according to the following recipe, answered all the purposes of the real sea-water in preserving alive plants and animals in his *Aquarium:*

Common table salt	81 parts.
Epsom Salts	7
Chloride of Magnesium	10 "
Chloride of Potassium	2 "

One pound avoirdupois of this compound will make nearly three gallons of sea water. But the best mode of mixing the salt and water is by means of a little glass instrument called a hydrometer, which can be procured of dealers in chemical apparatus. If one of these that is used to examine acids, and called an *acidimetre*, is procured, it will be found to be numbered on its graduated scale in numbers running from the top downwards. Now, when it is placed in pure fresh water it should float at zero, but, in sea water, at a point somewhere about three and a half or between the degrees marked three and four. If then we dissolve all our salt, say three pounds, in as much water as will just float the hydrometer and keep adding water until we find it floats at the point mentioned, we shall have it of the right strength. When the salts are to be mixed, it is best to do so in a tub or some other vessel, and not in the tank itself, for the reason that it is preferable to let it stand for a day to allow all sand and dust that might have been in the salts to settle, when it will become perfectly clear and bright and can be introduced into the tank. Artificial sea-water has one disadvantage, and that is, that it has to be seasoned, in other words, it has to be used about a week before we can introduce our animals, and for that purpose we put in as much *Ulva* and *Enteromorpha* as we can and leave it in the sun, when we shall see the plants give off abundance

of oxygen; and they will also, although unseen to us, give off seeds that seem more speedily to prepare the water for the introduction of the animals which we proceed to place therein, beginning with the zoöphytes and ending with the crabs, which are the tenderest of all marine stock used in an *Aquarium*.

CHAPTER X.

PLANTS FOR THE MARINE TANK.

Difference between Marine and Fresh-water Vegetation—Green Algæ best for the Aquarium—Danger of using olive-colored Algæ—Ulva latissima—Monster Fronds—Action of Sun on the Ulva—Ulva lactuca—Ulva linza—Plants on Snail's backs—Enteromorpha compressa—The Ocean Grove—E. intestinalis—Bryopsis plumosa—Cladophora arcta—C. rupestris—Diatomaceæ—Four Plants growing one on another—Codium tomentosum—Porphyra laciniata—Grinnella Americana—Ptilota elegans—Chondrus crispus—Padina povonia—Desmarestia, etc.

Nothing distinguishes the marine and fresh-water tanks in appearance more than the vegetation contained in them; for instance, in the large fronds of the bright green *Ulva*, the pink *Grinnellia*, the purple *Porphyra*, and the many and brilliant colored *Padina*, when compared with the differently tinted but always green color of the fresh-water plants. Then, whilst the fresh-water plants may generally be torn up, either with or without roots, and seem to flourish, the marine algæ, when detached from stones and rocks upon which they grow, mostly perish—requiring us, therefore, either to choose those that are fixed to small portions of stone or, with a hammer and chisel, chip off from the larger rocks small pieces bearing such of the algæ as we think will grow in our *Aquarium*. Still, all the sea-weeds, as they

are improperly termed, will not do for our tanks; many will either not grow at all or will soil the water when so doing and render it unfit for the habitance of other species and animals.

As a general rule, let it be borne in mind that the green algæ, or, as botanists have named them, *Chlorosperms*, are always the best for the *Aquarium*, being the cleanest, best aërators, and, at the same time, easiest obtained and replaced when anything happens to require a change. Let all the olive varieties—the fuci, so common covering every stone and rock on our shores—be discarded as worse than useless, as they give off a mucous substance which renders the water of the tank obscure and decomposing, soon turning it foul, so that it destroys other tenderer species. I have tried many times, and many of the olive species of all sizes in vain; even when beginning with young plants, it has been the same in the end when they have become old enough to be despotic, for they then have asserted their powers as destroyers, and killed my other plants. Some of them would look very well in a tank, as the *Fucus vesiculosus* and *F. serratus*, their deep olive fronds contrasting with the lighter colored *Ulva* and *Delesseria;* but, unfortunately, they cannot be introduced with any safety. Their fronds, however, on the sea-shore serve as a refuge for a multitude of strange forms, and, therefore, present a fine hunting-ground for the naturalist, where he may nearly always be sure of plentiful sport.

The only plants I can, with any confidence, recommend to beginners are the *Ulva latissima*, *U. linza* and *Enter-*

omorpha compressa. They are found on almost all coasts, at the very margin of high-water, and sometimes associated with *Ulva lactuca*, *Enteromorpha intestinalis* and *Bryopsis plumosa*, which may be also introduced with safety into a tank by a beginner.

The *Ulva latissima*, or common green laver, or (as it is also called) sea lettuce, which plant it much resembles, is found very commonly at several points near New York. I have observed fronds, full two feet in length by eighteen inches wide, at Greenpoint, Long Island, though Landsborough gives, as its extreme length, eighteen inches. These monsters would look well in a mammoth *Aquarium;* but, in our smaller tanks, fronds of from two to eight inches in length are the best. They are always attached to stones, which, as I have said, is the case with all marine plants, though the *ulva*, as well as some few others, will live detached and floating in our tank, but when so situated, are not ornamental. They have no true root, but derive all their sustenance through the surface of their leaves, or, as they are called, "*fronds.*"

The *Ulva latissima* can be easily recognized from its resemblance to the common garden lettuce, and makes a very pretty ornament for the *Aquarium;* from its bright green color and the curiously puckered edge, it generally has and would need no stronger recommendation to our notice, even if it were not such a useful plant and such a good aërator of the water. Specimens should be selected which have not been attacked by snails and crabs, for the fronds will soon assume a ragged aspect in an *Aquarium* where whelks and soldier-crabs are kept with it. This particu-

lar *ulva* is one, if not the best of the algæ used as an aërator of the water for a tank; and, when placed in the sun, will soon be covered with innumerable minute bubbles of oxygen, which buoy it up in a very graceful manner; but, when a sudden cloud passes before the sun, the bubbles will rise to the surface, and the frond fall to the bottom. On dark days, this plant, more than any other, shows the want of the sun's light, and will remain dark and dull at the bottom of the tank, but brightens again on the first sunny day. This plant goes under several names, as *sea-lettuce*, from its resemblance to the garden vegetable of that name; *oyster-green*, because it is employed to cover oysters; and *green laver*, as it is employed for culinary purposes when another algæ called *Porphyra* cannot be procured, but it is not thought to be so good as that.

Ulva lactuca is very much like the *U. latissima* in appearance and properties as an aërator for the tank, but is not so common, and is of a lighter green color and more tender in texture.

Ulva linza is not near as common as the two former plants, and is longer in proportion to its breadth. I have a plant of about eight inches in length, growing on the back of a *Buccinum*, or sea-snail, which the suicidal mollusc turns upon when hungry, and it has consequently become very shabby. It is a curious sight to see this shellfish travelling around the tank with this ocean tree upon his back. I have seen snails with quite a forest of *ulva* upon their shells.

The *Enteromorpha compressa*, or common sea-grass, is found

in abundance covering the stones on every sandy beach near our city. The fronds of this species are variable in width from a fine green ribbon, hardly wider than sewing thread, to sometimes, such a width as to cause it to be mistaken for the last species described. When it decays, it becomes pearly white, and in this state children call it *sea-thread*. If we seize a large bunch of this plant, and, taking it home, put it into fresh salt-water in a glass jar, we shall most likely find we have got more than we expected, for its numerous fronds are the haunts of many of the smaller animals, such as shrimps, sandskippers, and worms, together with, sometimes, molluscs, and such small fish as minnows, and the like. It grows very well in the *Aquarium*, and aërates the water capitally. It looks well when about a quarter to a half of a tank is planted with it, so as to make a bottom of a grassy appearance, and forming a miniature forest, where,

"Under the shade of melancholy boughs,"

fish and smaller inhabitants take refuge.

Enteromorpha intestinalis resembles very much the last species, but is wider in proportion to its length; and its frond is also tubular and hollow. This is one of those curious salt-water plants that will live sometimes in brackish water, and even has been observed in fresh-water streams. It varies in length and breadth, sometimes short and narrow, at other times two feet broad and three inches in length. This species, unlike the last, is never branched; but the fronds grow singly and alone. It looks

well in an *Aquarium* when about eight inches in length, and has somewhat the appearance of a narrow *ulva*.

Bryopsis plumosa, or feathery moss, as its name designates, is a beautiful plant both in form and color, not being of so yellow a shade of green as the *Ulva* or *Enteromorpha*, but of a colder color, and standing up in the water like an accumulation of feathers. It is found pretty plentifully upon some of the rocky parts of the coast of the United States, growing either in the open water or skirting the many pools left by the receding tide. When dried on paper, it adheres well and appears of a rich glossy green. It is an excellent aërator of the water, its many branches appearing in the sunshine covered with minute bubbles of oxygen, which they entangle and arrest in their upward passage and hold until the gas is considerably dissolved in the water. It looks well when a bunch is placed on some high projecting portion of the rockwork, where, when the sun is obscured, it remains hanging down; but, as soon as it feels his light, stands up in an assemblage of seemingly minute pine trees.

Cladophora arcta and *Rupestris* resemble very much, especially the last, fine varieties of *Bryopsis*, and are recommended by naturalists for use in the *Aquarium*. From being green algæ, they can with safety be introduced into the tank, as we can soon find out whether they thrive. Both these two species and *Bryopsis plumosa* are generally covered with smaller algæ of the family *Diatomaceæ* and, therefore, present a rich harvest to the microscopist. *Cladophora rupestris* is very common on the rocky points of our coast. To show how nature has arranged these plants so

that one may serve as a support to another, I may mention that I have found *Fucus* bearing *Cladophora* on its frond and upon whose branches, again, there have been *Melosira*, whose frond bore *Synedra*. We thus have four plants, one growing upon another, but none of them serving as sustenance to the one that is growing on it any more than the rock does to which they are all attached, for all these algæ derive the matter to build up their tissues through the surface of their leaves or fronds and have no real root, but only a sucker by which they can be attached to other plants and rocks.

Codium tomentossum has also been recommended by writers for an *Aquarium*-aërator, but I have never tried it. It resembles somewhat an *Enteromorpha*, still, altogether, looks more like a sponge than an alga.

Porphyra laciniata is a beautiful plant, of a fine purple or sometimes dark fawn color, and resembles in form the *Ulva latissima*. It, as well as that species, is eaten under the name, in England and Scotland, of *laver*, this being the *purple laver* while *Ulva* is the *green laver*. In Ireland it goes under the name of *Stoke*. Its color and the ease with which it grows in confinement recommend it to our notice as an inhabitant of the *Aquarium*, whilst it also gives off oxygen as freely as *Ulva latissima*.

Of the red algæ or *Rhodosperms* only a comparatively few can be introduced into our tank; and the best of these, and at the same time the most common is *Grinnellia Americana*, which is of a beautiful light blood-red color. It grows in some profusion at different points of the American coast, always upon rocks. Its form is that

of a chestnut-tree leaf, having also a mid-rib; and, indeed, resembles, when cast upon the shore, an autumn-tinted leaf from some tree. It seems to do well if the water in the tank has been in use under the influence of the green algæ for some time, but cannot be introduced before, or it will be sure to die, turning first orange and then white.

The beautiful *Ptilota elegans* I have not yet been able to make succeed; but do not despair of eventually doing so. It would be a very ornamental plant for a tank, with its long, deep-red, feathery branches waving in the sun.

Chondrus crispus, the carrageen or *Irish-moss* of commerce, is said to grow well in confinement, and may, therefore, with safety be introduced. It is of a purplish-red color when living, but becomes yellowish-grey when dried. It is sold for the purpose of making a gelatinous broth and which forms a light, easily-digested food for invalids.

The brilliant little *Padina pavonia*, although an uncommon plant, is sometimes found when searching for other algæ; and may be introduced into our collection, if not as an aërator, at least on account of its beauty. It resembles somewhat the expanded tail of the peacock. Doctor Harvey says: "When growing under water, this resemblance is peculiarly striking, the fringes of capillary fibres which adorn it decomposing the rays of light and giving rainbow-colors to the surface." It grows in shallow pools at half-tide level and on rocks where it is not exposed to the roughness of the waves. There are many more algæ found on our coast, a few of which may be

enumerated here, for the purpose of aiding collectors when searching for stock for *Aquaria*.

Of the *Melanospermæ* or olive-colored algæ, the following might be introduced into an *Aquarium*: *Desmarestia viridis* and *aculeata*, both of which are common at Hurlgate; *Ectocarpus littoralis, siliculosus, viridis, lutosus* and *Dietziæ*, the first of which is common all along the New York coast.

To the *Rhodospermæ*, which I have mentioned above, may be added the following:

Chondria Baileyeana.
Rhodomela subfusca
Polysiphonia formosa.
" *subtilissima.*
" *Olneyi.*
" *Harveyi.*
" *variegata.*
" *nigrescens.*
" *fastigiata.*
Dasya elegans.
Rhodomenia palmata.
Chondrus crispus.
Ceramium arachnoideum.
Calithamnion Baileyii.
" *polyspermum.*
" *byssoideum.*
" *Dietziæ.*
" *Americanum.*
" *cruciatum.*
" *virgulatum.*

CHAPTER XI.

FISH FOR THE MARINE AQUARIUM.

Some Fish will live in either Fresh or Salt water—Fish require Real Sea Water or Artificial Sea Water that has been well seasoned—Anemones may be introduced into Fresh Artificial Sea Water—Advantage of Fish in an Aquarium—The Minnow or Killi-fish—"Minny" a tame Fish—Singular effect of Fright on the Minnow—Big Killie—Common and Spotted Bergall—Sand Smelt—Sticklebacks—Variegated Goby—Sea-weed Blenny—Fringed Blenny—Eels—Striped Mullet—Sea-Scorpions—Pipefishes and their curious Habits—Suckers—Six-banded Chasmodes—Sand Launce—Sea Horse.

THE fish used for the purpose of stocking a marine *Aquarium* are, of course, different in characteristics from those introduced into a fresh-water tank, inasmuch as few fish will live in both fresh and salt water. There are some, however, that will do so: as, the minnow (*Fundulus fasciatus*) and the sticklebacks (*Gasterosteus*). If either of these fish are taken out of salt water and thrown, at once, into fresh, they will sink to the bottom, but after about an hour begin to feel more comfortable and make themselves at home. I have, now and then, had minnows which have been taken out of Long Island Sound, that would not live when introduced into fresh water.

As in the fresh-water tank, so with the marine one, the fish are the last objects introduced; as they are the highest

organized and, therefore, the most delicate creatures. From this circumstance they require real sea water or artificial sea water that has been some time in use, although I have found that minnows may be introduced about a week after the tank has been in vigorous operation and, if they are so introduced, the other fish can be the sooner admitted, as they seem, in some way, to prepare the water for the more delicate creatures. I have also observed that many of the anemones may be placed in artificial water that has been in use only a day, and that they will very soon open in it. There are some species, however, that will not bear the artificial water, until it has been in use at least a week. The American species (*Actinia marginata*) is one of these.

Mr. Humphreys, in his "Ocean Gardens," says: "A marine *Aquarium* may be rendered interesting without the introduction of fish; and as their presence requires that the water should be, once each day, aërated by means of additional water, introduced by the syringe or by a drip, continuing for some time from another vessel," he considers that they may be, with advantage, left out; but I cannot agree with him at all: a tank without fish, at the best, is but a quiet flower garden; for, what are the zoöphytes but the flowers of the *Aquarium*, while all within is still and solemn? but, let us introduce one or two fish, and all is a display of life and activity; and, as for changing the water, a vessel in which this is done is not an *Aquarium*. I have always kept fish in my marine tank, and the water in it has never required to be changed, unless when some animal has died in a corner or nook unseen and so fouled the water. We derive amusement and instruction from the

varied movements of the fish and pleasure in feeding them and rendering them tame, for many in an *Aquarium* may be made so tame that they will eat out of our hand and allow us to stroke them gently.

No doubt, almost any of the smaller fish that are caught along our coast may be, in time, made to flourish in a sufficiently capacious tank; but below I give such fish as I have tried or are mentioned by the different writers on the subject, as desirable for the marine *Aquarium*.

The minnow (*Fundulus fasciatus* Pl. VI. Fig. 1) stands first for our collection, as he will bear a deal of rough handling that would be fatal to his more delicate relatives. As Mr. Hibberd very correctly remarks, "An *Aquarium* without minnows is no *Aquarium* at all—it is a make-shift." The minnow has been called killi-fish in the United States from living in small creeks and streams which were called by the Dutch "kills." He soon gets used to confinement, and in a short time will become so tame as to be fed from the hand. Those that I have will come to the surface and nibble my finger (as I have before mentioned), or follow me as I pass around the tank: thus exhibiting a seeming attachment that we could not expect to find in fish. One of my tame minnows is quite a pet, and has received the appellation of "Minny;" he has a peculiar way of staring me in the face through the side of his glass-prison, especially when he considers feeding-time has come. He will, also, allow me to stroke him gently, but sometimes he resents such familiarity, by turning suddenly around and giving me an astonished look, as if wondering at my impudence.

The minnow is a very common fish along the coast, and can be obtained in any quantity, and of sizes from half an inch to three inches, by means of a fine "seap" net. This little creature is used as bait by anglers for larger fish, but is not the same animal as the English minnow (*Leuciscus phoxinus*). The killi-fish is not pretty in form or color, having what is termed its face upon the same level as its back, and being of a dusky greenish hue on the back with a lighter hued belly. Along the sides there are indications of dusky bars, which, on the tail, become distinctly marked as black bars or lines of interrupted black dots. This little fish, however, presents much variety in its markings, sometimes having from two to five longitudinal stripes upon its sides. The killie will bear very rough treatment and great and sudden changes of heat and cold; for, as I have before mentioned, I have kept them beneath ice an inch or two thick, and yet they were as lively as if the water were of a comfortable warmth. Fright often makes them assume a pale color, which I have also observed to take place when they are ill or kept in the dark. Some minnows that I had in a wooden pail, where no sun fell upon them, were quite light colored, but became dark in about a quarter of an hour after they were placed in a tank that was standing in the sun. Disease does not often attack the minnow; and when it does, he will generally recover if thrown into a tank of fresh water well aërated. There is another species of killi-fish, the big killie (*Fundulus viridescens*) found in the bays and brackish streams of the American coast. It is larger than the last named species, often reaching the length of five inches. We have likewise four other species

of minnow in the State of New York, all of which might, no doubt, be introduced into an *Aquarium*.

The Blennies are recommended by writers on the *Aquarium*, as also are the Gobies, Wrasse and Rockling, the two latter of which are not found on the American coast. I have tried flounders, but as yet have not been able to make them succeed. Eels may be introduced, if they are not too large. Their peculiar mode of swimming contrasts well with that of other fish; but they are voracious animals, and will attack the molluscs if not well fed. Below, I have taken into consideration these and other fish separately, all of which may be introduced into an *Aquarium*.

The Common Bergall (*Ctenolabrus cæruleus*) I have tried, but the specimens I had were injured in coming to me, and this, most likely, was the reason I could not make them live over three or four days. The bergall is a curious but not pretty looking fish. It is caught along with the other American species, the spotted bergall (*C. uninotatus*), on the coast in quantities. Those that I had were taken with a hook, and although there was no apparent injury, they languished and died. As a general rule, fish caught with a hook will not live any length of time in an *Aquarium*. I have observed sun-fish, that had been taken in this way, die in about a week or ten days after being caught, whilst those secured by a net were still living and apparently happy.

The Sand-smelt or anchovy (*Atherina notata*—Pl. VII., Fig. 1), is a beautiful little fish; and from having white sides, with a broad silver stripe running down each, has re-

ceived the name of "shiner" from boys, who take it sometimes by means of nets. We have here a tender creature which, therefore, requires care in transportation; but when once domesticated in an *Aquarium*, it rivals the gold-fish of the fresh-water tank in the brilliancy of its glistening sides, and is, besides, almost as graceful in outline. It is a fish common along the American coast, but not so much so now as it was twenty years back, when they were caught from the city wharfs and used as bait for larger fish. The extreme length that they reach is about three inches.

The Sticklebacks (*Gasterosteus*) are fish that can be used for both the fresh water and marine collections. (We have four species on the coast and through the State of New York, as I have mentioned in chapter six). They may be all introduced in a marine *Aquarium.*

The following fish (or rather their British representatives) have been recommended by English writers on the subject, as fit objects for the marine tank, and are all said to flourish when introduced and judiciously grouped:

The variegated Goby (*Gobius alepidotus*) which is a curious fish in form and, also, from having no scales, would be a good object for the marine *Aquarium*, but it is found rarely in the harbor of New York. It reaches only two inches in length.

The sea-weed Blenny (*Blennius fucorum*) is very scarce with us; but bordered eel-pout or fringed Blenny (*Zoarces fimbriatus*) is found commonly on our eastern coast in the months of February and March.

The common New York eel (*Anguilla tenuirostris*) lives

well in either a marine or fresh water-collection; indeed, I have had them in water in which all the other animals have died, and by their decay had rendered foul. The silver eel of the fishermen is only a variety of this species.

The mullets are said to be very tough fish, having a singular power of maintaining their existence in the confinement of an *Aquarium*. We have six species. The most common is the striped mullet (*Mugil lineatus*). It sometimes reaches the length of nearly eight inches.

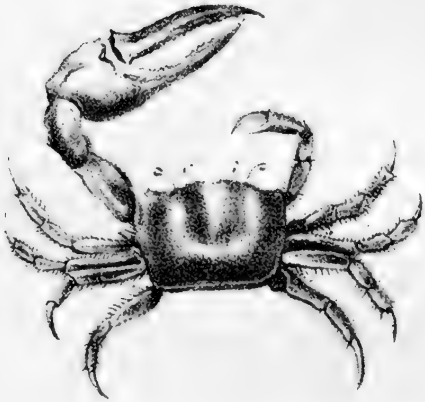
Mr. Gosse recommends the following fish, in addition to those given above, as species that he has found to succeed in a marine *Aquarium*.

The sea-scorpions (*Scorpena*) of which genus we find two species on our coast, the *S. porgus* or small sea-scorpion and the *S. rupo* or spotted sea-scorpion, both of which are ugly to look upon, but it seem as if the uglier a fish is, the longer will he live in confinement. Mr. Gosse enumerates the hideous pipefishes among his favorites.

We have four species of pipefish on the American coast, which are named as follows: The American pipefish (*Fistularia serrata*); the spotted pipefish (*T. tabbacaria*); the banded pipefish (*Syngnathus fasciatus*) and the green pipefish (*S. viridescens*).

The green pipefish is the most common in the waters of New York, and is frequently taken as far up the Hudson River as Sing Sing. The other three species are scarce. The *S. viridescens* is to be looked for among the aquatic plants along the shores of the Hudson, where this fish keeps chiefly and breeds in the slightly brackish water.

The pipefishes all resemble elongated sticklebacks in



appearance. Mr. Hibberd, in his "Rustic Adornments," says, "I am very partial to pipe-fishes, not for their activity, for they are lazy, dreamy creatures, but for their queer performances—they are the antipodean acrobats of the *Aquarium*. They sink down slowly to the bottom, and there poise themselves in perpendicular attitudes, remaining motionless for some minutes, either on the tail or on the head, after the fashion of an 'indiarubber brother.' Indeed, they assume every possible attitude except the horizontal one; and, like the buffoons on the human stage, get laughed at for their pains. The other day I was amused to see a fine specimen of *Syngnathus acus* proceed slowly and solemnly fluttering, as he went, his useless dorsal fin, and dropping his head beside a waving frond of *Rhodymenia*, left his tail to swing over, till he brought himself to an angle of about forty degrees, where he remained for several minutes immovable, like one of the brothers Seigrist thrusting himself out from *la perche*. Will M. Seigrist stand head downwards on the floor at Drury Lane, and poise himself unsupported at forty degrees, and then, swing his body to and fro, bring himself head upwards to a similar angle? I commend the pipefishes' performance to the whole tribe of mountebanks, as a great hit if they can accomplish it. In a very small tank the pipefishes are rather unhappy; they want plenty of room."

Mr. Gosse speaks of the suckers as good fish for the *Aquarium;* and of which there are fourteen species, several of them living in fresh water. There is one marine species quite common with us, and is to be seen exposed for sale in New York markets in autumn. This is the com-

mon sucker (*Catostomus communis*); but it is comparatively a large fish, measuring fourteen inches in length when full grown, and, therefore, too big for a parlor *Aquarium*.

Mr. Hibberd recommends the *Blennius pholis* or common Tansy of the English, which answers to our six-banded Chasmodes (*Chasmodes bosquianus*). It is, however, a rare fish in America. He likewise recommends the sand-launce, a local species of which (*Ammodytes Americanus*) is not rare. It is a small fish about four inches in length, and, consequently, a good one for the *Aquarium*. They bury themselves in the sand when the tide recedes, and may be procured by being dug out.

There is one funny little creature that stands alone among fishes, in having a prehensible tail, by means of which he holds on to sea-weeds or floating objects. This is the Hudson river sea-horse (*Hippocampus Hudsonius*) a figure of which I have given (Pl. I., Fig. 1), and being only six inches in length when full grown, and found so near to us might, if it would live, be an acquisition to a marine *Aquarium*. I have not, as yet, been able to try it, but think that, from its resemblance to the pipefishes and sticklebacks, and also from the seeming toughness, not only of its shell, but of its constitution, that it might be introduced with advantage.

CHAPTER XII.

CRUSTACEA AND MOLLUSCA FOR THE MARINE AQUARIUM.

The Scavengers of the Marine Aquarium—Aiding them in their Labors—Hermit Crabs—"Hermits" habitations—Pugnacity of "Hermits"—"Hermits" changing their Lodgings—Death of "Hermits"—Fiddler Crab—The American Soldier Crab—Edible Crab—Soft-shell Crabs—The Lupa's mode of burying himself—Sea-spider—King-crab—Effect of feeding Hogs on them—Lobster—Shrimp—Buccinum obsoletum—Natica duplicata—Pyrula canaliculata—Fusus cinereus—Crepidulæ—Oysters—Anomia—Mussels—Clams—Scallops—The blue "eyes."

In the marine, as in the fresh-water *Aquarium*, we must have scavengers to remove decaying vegetable and animal matter, as well as to graze on the confervæ and keep the glass sides of our tank clear and bright. However, it will be found that the marine molluscs do not perform that portion of their duty in as satisfactory a manner as those of the fresh-water tank. In consequence of this, I have been in the habit, once or twice a month, of aiding them in their useful labors and in cleaning the glass with a sponge, attached to the end of a small rod of wood.

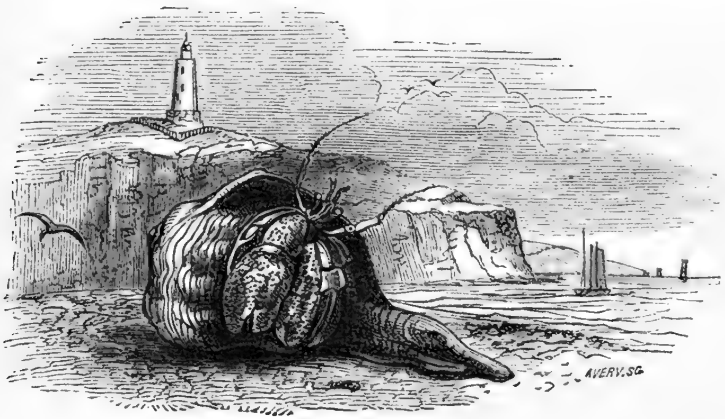
We shall, first, take into consideration the crustaceous animals that may be introduced with advantage into the marine *Aquarium;* and in beginning, I should state my belief that most, if not all, of the family of *Crustacea* can, with a little extra care and attention, be made to live and

thrive in a sufficiently capacious tank, if all other requisites are taken into consideration and properly attended to, so as to imitate, as nearly as possible, the natural habitat of each of these creatures, and care being had not to excite them too much, by going near the tank oftener than will be necessary for feeding, observation or attention to their well-being; for it must be remembered that deep-sea creatures are not accustomed to look upon man, and if we wish to keep them (and many of them are strange of form and will well repay a little extra attention), we must be particular not to disturb them too often.

Among the *Crustacea*—or "animals with their bodies divided into movable rings more or less distinct, having an outer coating of a calcareous (formed of lime) or membranous texture, more or less solid, and which, in many of them, as the lobster and crab, contain a coloring matter, which turns of a brilliant scarlet on immersion in warm water or alcohol"—that which has been recognized in England as fair prey for the naturalist, and to introduce into his *Aquarium*, presents a form and habits that we would hardly expect to meet with in these creatures as they are exhibited to us in the common edible crab, is the strange little hermit crab—two species of which are found upon the New York coast.

The first of these (*Pagurus pollicaris*), is more rare than the next to be described, and the largest of the American species. Its right hand sometimes being 0.8 of an inch long. It is frequently found in the shell of the *Fulgur carica*. It is difficult to meet with a perfect specimen, as they are frequently found deprived of their antennæ and

of one or both their eyes. This is attributed by fishermen to attacks from the common black-fish. It is sometimes



Warty Hermit Crab.

distinguished as the *Warty Hermit crab.* Hermit crabs, or, as naturalists familiarly term them "*Hermits,*" are, also, called soldier-crabs, from their pugnacious propensities; although this name has likewise been applied to another species (*Gelasimus vocans*), as I shall mention further on. The "Hermits" are a class of crabs that have no hardened shell on the posterior portion of their bodies, the claws and legs only being shielded by the horny-case that we find upon other crabs. For the reason of being thus unprotected by nature, they have to find for themselves some coating to ward off the attacks of enemies, and the empty shells of many of the univalves are taken possession of by these creatures, who thus, literally, carry their houses on their backs.

For this mode of life the "hermit" is wonderfully adapted, so that we are almost tempted to assert, on the authority of this fact alone, that univalve shells must have been created before "hermits," because, had it been otherwise, these poor little creatures would have been left to the mercies of fish, who are not at all averse to the tender bodies of our heroes. In order that he may retain his habitation and covering, the "hermit" is supplied with two small hooked claws at the extreme end of his body, with which he lays hold of one of the coils of the shell that he has seen fit to choose and appropriate as his own for the time being. The body of the "hermit" is essentially formed for introduction into empty univalve shells, as it more nearly resembles a worm than the body of a crab, and has a twist in it, in the form of a spiral, so that it exactly fits the coils of an empty shell.

As I said before, they are extremely pugnacious creatures; and if two are kept in the same tank, each will not be satisfied with appropriating a separate portion of it to himself, but they will travel into each other's dominions, and when they meet—when crab meets crab—"then comes the tug of war." They fall to with a will, rolling over each other like two dogs and throwing their claws about, snapping them in their little fury; and sometimes, although not always, the fight will end in the death or mutilation of one of the combatants. Oftener one will become victor and assert his power by always attacking the other when they meet, whilst the vanquished will seem to remember the combat and retreat whenever he sees the other coming.

I have never seen our common "hermit" (*P. longicarpus*)

fight with such fury, as English writers tell us the *P. Bernhardus* (which is found in large quantities upon their coast) is apt to do. Our native species seems rather to be a peaceful animal.

When the "hermit" grows, he is forced, of course, to give up the shell which he occupies and search for another, travelling about, trying and examining every empty univalve shell that comes in his way, until he finds one that exactly fits, when in he goes, and is at home in an instant. The mode of change of domicil is so well described by the Rev. J. G. Wood in his "Common objects of the sea-shore" (a book to be highly recommended to the notice of naturalists), that I give it in preference to anything that I could lay before my readers. "When a hermit," says that gentleman, "desires to change his habitation, he goes through a curious series of performances, which, if he had hands, we should be disposed to call manipulations. A shell lies on the ground, and the hermit seizes it with his claws and feet, twists it about with wonderful dexterity, as if testing its weight; and having examined every portion of its exterior, he proceeds to satisfy himself about the interior. For this purpose he pushes his fore legs as far into the shell as they will reach, and probes, with their assistance, every spot that can be touched. If this examination satisfies him, he whisks himself into the shell with such rapidity that he seems to have been acted upon by a spring. Such a scene as this will not be witnessed in the sea; but when hermits are placed in a tank or vase, they seem to be rather given to 'flitting.'" This latter

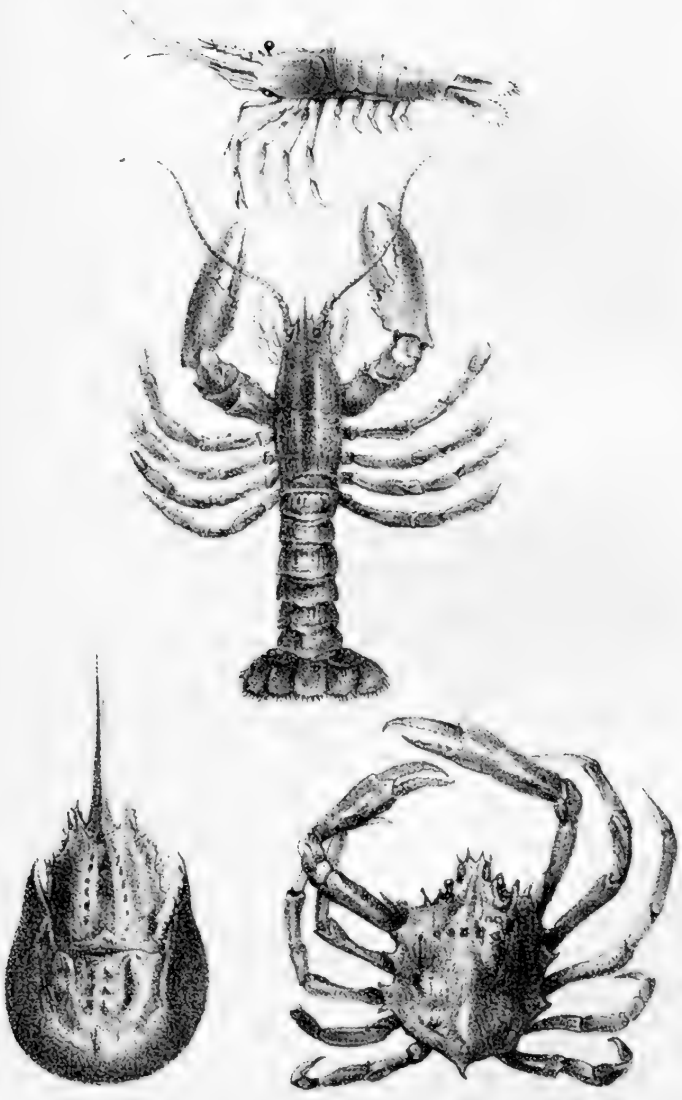
fact may present itself when the *P. Bernhardus* is watched; but it is by no means so with the *P. longicarpus* of our coast, which is the one that my readers will be most likely to obtain, although *P. Bernhardus* has been observed by Dr. Gould on the coast of Massachusetts.

It is a curious fact, that when a hermit in captivity feels unwell, he crawls out of his shell; and, soon after dies. This propensity is shared by the tube-inhabiting worms, as the *Serpulæ*. The habit is the more remarkable, as the usual instinct of animals leads them to the most retired spots they can find and there resign themselves to death.

Small Hermit Crab.

The other hermit crab (*Pagurgus longicarpus*) is very common on our coast and may be caught during the spring or autumn at low tide in great numbers, bearing shells of *Buccinum*, *Pyrula*, *Natica*, *Fusus* and sometimes others. They generally are small in size; the largest mentioned by Dr. De Kay measuring 1.5 inches in length.

The common Fidler Crab (*Gelasimus vocans*—Plate VII. Fig. 3), when young, may be introduced into the *Aq arium*,



and, though a creeping crab, it seems to thrive. The difference in form between the creeping and swimming crabs consists in the former having all their legs fashioned in a similar manner, while the latter have the hindermost pair of legs flattened into a pair of oars, by which they "skull" themselves along, and it is by such means of progression they move through the water, the legs that are to go forwards being drawn up under the body, whilst the others are extended behind as the oar-shaped leg propels the body onwards. It has been asserted, that all crabs move sideways; this is true of many, but the "hermit" oftener moves backwards, pushing his cumbersome shell on behind him. The *Gelasimus* has been also called the soldier-crab from its fighting propensities, elevating its largest claw on the least alarm as it moves over the wet sand in which it burrows and seems most to live. When it is introduced into the water, it attempts to get out as soon as possible; and from this fact it might seem that it could not become an inhabitant of the *Aquarium;* but I have one that has been in my tank for the last four months and does not appear now to be dissatisfied with its place of residence.

The common Edible Crab (*Lupa dicantha*—Plate VII. Fig. 2) is an excellent inhabitant of an *Aquarium* and belongs to the class of swimming crabs. It is found in large quantities on the American coast from Florida to Cape Cod, Massachusetts, but when over an inch or two in length, it is too large for our purpose. The process of sloughing or casting the shell occurs annually and is of short duration, scarcely ever exceeding the period of forty-eight

hours from the time of getting rid of the old shell, until the new one is firmly consolidated. During this interval, they are known under the name of *soft-shell crabs*, or shedders, and are sought after with great avidity. They are considered a great luxury when fried, and are often sold with us at the rate of two dollars the dozen. The *Lupa* is fond of burying himself in the sand, and we shall be able to observe this habit whenever we use silver-sand as part of the bottom of our tank. The mode of sinking himself in the sand is curious and the observing of it never fails to make me smile. It is as follows: the hind part is thrust a little way into the sand, and then the fore part brought down to its level; and, again, the hind part is sunk, the fore part after, and so on until the whole of the creature is beneath the level, when he blows the sand away from his mouth and eyes, which remain exposed; but, usually, the eyes and antennæ are all that are to be seen, moving around continually on all sides, as if watching for prey. From his having this strange habit, we shall not be able at all times to find our friend, unless we look sharp or have the bottom of our tank formed entirely of pebbles and empty shells, but even then he will attempt to hide himself under them. The burying is done in an instant, and very often the *Lupa* will also kick the sand over himself with his hind legs, thus securely hiding himself from enemies.

The Sea-spider, or Spider Crab (*Libinica caniculata*—Plate VIII., Fig. 4), I understand has been domesticated, but I have never tried it. It is a curiously shaped animal, and is

taken in such large quantities that, when obtained by a seine, it is often used as manure. Its usual places of resort are upon oyster-beds, where it is thought to commit great ravages by destroying the spawn of the oyster. There are several other species of crabs to be obtained on the American coast, and most of them could, no doubt, be introduced with advantage.

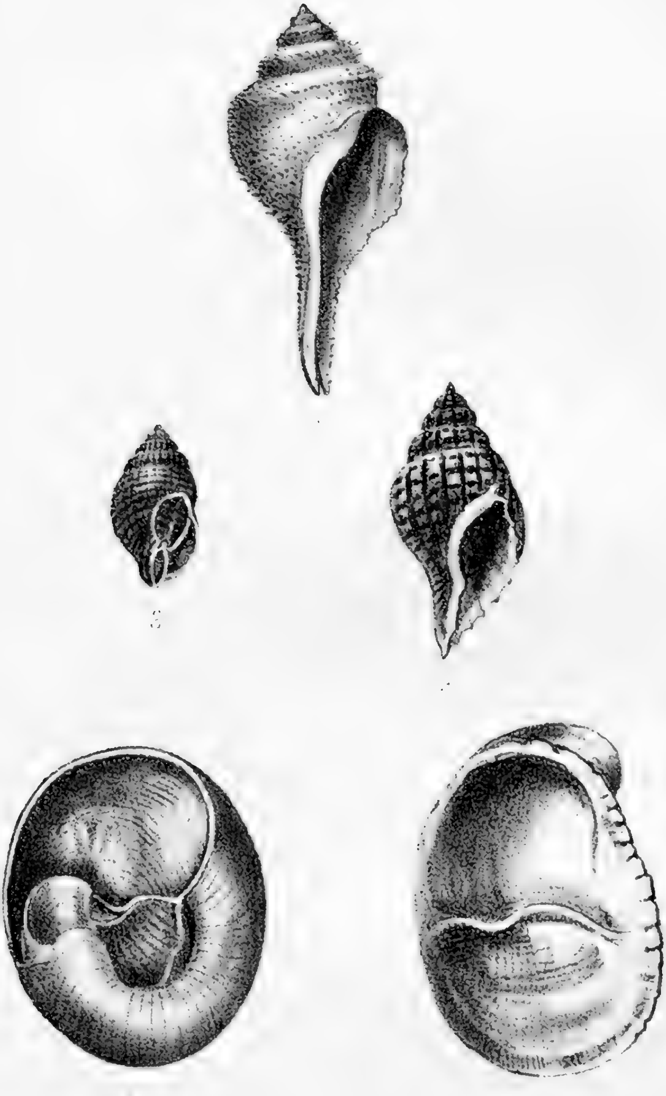
The Molucca Crab, King-crab, Horse-foot or Horse-bunker (*Polyphemus occidentalis*—Plate VIII., Fig. 3), all of which names it bears, is extremely common on some parts of the shores of New York State. It is called Horse-foot on account of its shape; and still retains, in some districts, the name given to it by the early English colonists, of King-crab, on account of its size. It is likewise called by fishermen the sauce-pan, on account of its shape. Its shell is sometimes made use of to bale out boats. These crabs come up on the shore at high-water, in the month of May, and are used to feed hogs upon; and, it is said, the latter must be fed on some other food a month or two before being slaughtered, as the flesh of those animals would, otherwise, be apt to retain a rank, disagreeable taste. The flesh of this crab is also eaten with avidity by chickens, whose eggs, it has been asserted, retain the same taste; but I have never found it so. It is sometimes used as food by man, when the flesh is carefully separated from the other parts. Dr. De Kay says, "They crawl along the bottom, and I have never seen them swimming near the surface. When thrown upon their backs, they inflect the anterior portion of the shield upon the posterior, and likewise turn it so far back, that,

with the aid of their tail as a lever, they succeed, after many awkward attempts, in recovering their natural position. They are frequently caught so abundantly as to be used as manure." This creature, if small, may be introduced into the *Aquarium;* but when full grown, it is much too large—the female, which is much the larger, reaches the length of twenty-two inches. They are a slow, stupid animal, however, creeping along the bottom, and, therefore, only of use as a curiosity, and by way of contrast (in their motions) to the other inhabitants.

Our Common Lobster (*Homarus Americanus*—Plate VIII., Fig. 2), can also, when young, be used as a denizen. This species has not, until lately, been well distinguished from the lobster of Europe. It attains a much greater size than the latter, and is, perhaps, the largest among the crustacea, as it sometimes attains the weight of twenty pounds; and Dr. De Kay mentions one of thirty-five pounds. They are found on rocky coasts; for instance, along the Long Island Sound, at Hurlgate.

The Shrimp (*Palemon vulgaris*—Plate VIII., Fig. 1). There are two species of shrimp on our shores, the above one being closely allied to the Prawn of England (*P. serratus*), but termed, among us, the shrimp, or big shrimp, in contradistinction to the next species, which is smaller in size. This, as well as the *Crangon septemspinosus*, or bait shrimp, cannot be kept any length of time in confinement, unless the water is constantly changed, as it seems to need the motion of the waves. I have preserved it alive for a week or two, but no longer. It makes good food, however, when small, for many of our fish.

Pl. 5



[illegible] lith. [illegible]

1. [illegible] canaliculata. 2. Buc. obsoletum. 3. Fus. [illegible]
4. Nat. duplicata. 5. Crep. fornicata.

After the crustaceous we come to those more important scavengers who keep the glass of our tank clean and bright, the Molluscs. The first of these which will be mentioned, because the most common, as it is picked up all along our shores, is the *Buccinum obsoletum* (Plate IX., Fig. 2).

It is the empty shell of this species that the small hermit crab inhabits, in preference to any other. The color of the shell is dark olive, or reddish brown, and the interior of the lip a purple black. In length, it seldom exceeds from half to three-quarters of an inch, although sometimes it is found an inch long. It is extremely voracious; and, therefore, makes a good servant for the tank, projecting its trunk from the shell and mowing the confervæ from off the glass—with a motion very much resembling that used by a man when mowing—as the animal swings his trunk from side to side.

The European Whelk (*B. undatum*) is found sparingly with us. It is highly recommended by English writers as a scavenger for the tank.

Natica duplicata (Plate IX., Fig. 4), is a very common shell on our coast, as we have a right to suppose, because we find hermit-crabs frequently inhabiting its shell.

Pyrula canaliculata (Plate IX., Fig. 1), is another common shell that hermits sometimes take a fancy to. It is know under the name of the Winkle, and is occasionally eaten.

Fusus cinereus (Plate IX., Fig. 3), is, also, a common coast shell; and is known under the name of the *Drill*, by our oystermen. It is said to be very destructive to the oyster by piercing or drilling small holes through the shell and destroying the animal. The means by which this is

effected has not been explained. I have never been able to keep the *Drill* alive any length of time in confinement.

The *Crepidulæ*—of which there are four species (*C. fornicata*—Plate IX., Fig. 5), although very common with us, I have not been able to keep in an Aquarium. These crepidulæ are found adhering to each other and to different shells and stones; and when adhering to a *Pecten*, the margin is observed to have undulations corresponding to the ribs of the latter. I have seen four or five adhering to each other. This is the little boat-shaped shell that we pick up on the margin of Long Island Sound. It makes a capital bottom for our tank, when mixed with *Anomia* and stones.

Many other univalve marine shells may be introduced; but I have tried very few as yet, being satisfied, generally, with the *Buccinum obsoletum*, which is easy to procure and a pretty good scavenger. Of the bivalves, none are safe in our Aquarium, for, when they die, it is generally with closed shells, and we do not find out their demise until the water is fouled by their decomposition and it is too late. Oysters (*Ostrea*) can be kept, for a short time, for curiosity, and when they are cut up they make good food for the crabs. The creature in the little gold-shell so common on the coast (*Anomia ephippium*), will not live more than two weeks, but whilst it does, it is an interesting object, with the fringed mantle. It is found alive in great quantities in the autumn and spring, at low tide, attached to stones and other shells; and, in the dead state, is strewn on every sandy shore both here and in Europe. I have often used it alone, or mixed with pebbles, as a bottom to my tank.

The common mussel (*Mytilus borealis*) I have not been able to make live; but it is a curious animal, and very common on Long Island coast, where it is used as manure. This creature fastens itself to a mass of small stones, and sometimes to rocks, by means of numerous glutinous cords—in this way preventing its being washed about at the mercy of the waves, or endangered by becoming a prey to fish, one of which, the common starfish, is very fond of it.

Clams (*Venus*) will not succeed in confinement. Neither will the pretty little scallop (*Pecten concentricus*). This little creature is extremely beautiful whilst it lives, as, besides the beautiful fringed mantle that hangs from the interior of each shell, it is provided with a row of bright metallic blue spots, which have been called eyes, and are arranged just near to the edge of each shell. These scallops are extremely lively animals when young, skipping a considerable distance by suddenly opening and closing their shells, and making a sharp, snapping noise when so doing. They are eaten by fish; and the broad muscular portion, being boiled and put into vinegar, is, by many persons, considered a great delicacy.

CHAPTER XIII.

ZOÖPHYTES.

Scientific definition of a Zoöphyte—Mr. Tugwell's definition—Classes of Zoöphytes—Hydraforms—Asteroids—Hellantholds—Insensibility of Zoöphytes to dissection—Hydra viridis—Turning a Hydra inside-out—Echinus—Starfish—Serpulæ—Appearance of an Anemone—Parts of an Anemone—Spike-cases—American species—Actinia rapiformis—Actinia marginata—Actinia dianthus—Rapacity of Anemones—Anemones seizing Men—A. coriaceæ—A. dianthus—A. carneola—A. obtruncata—A. sipunculoides—American species.

What is a *Zoöphyte*? This is a question that my reader will be likely to ask—as it has been by many persons. In answer, allow me, first, to give the scientific definition of this creature, at the same time attempting to make it clear to the unscientific reader. Mr. Quackett, in his Histology, says: "This word, *zoöphyte*, literally signifies animal-plant, and is a term very applicable to certain groups of species, but not to all that have, from time to time, been included in this order." As far as it goes, this is all very well; but do you, gentle reader, think that you would be able to distinguish a *zoöphyte*, were you to see one, from this description? It is true that the word *Zoöphyte* comes from the Greek words *zoön*, "an animal," and *phyton* "a plant;" but *zoöphytes* are not plants; they are animals, just as much as you or I are,

however much above animals we may consider ourselves in the scale of nature. I do not mean to say that a *Zoöphyte* at all resembles a human creature in appearance; but both of them consist of flesh, blood and bone, and have will and power to accomplish the promptings of that will. "Still," says the reader, "what is a *Zoöphyte?* Well, then, let us try again. Mr. Tugwell, in his "Manual of the Sea Anemones" (a little book that I very highly recommend), observes: "The meaning of *Zoöphyte* is a living plant; and the animals included in this class are so called, because, in the first place, they were for a long time considered to be vegetables; and because, secondly, a vast number of individuals are found united, like flowers on a plant, by a common stem. If you go down to the beach and pick up the first object —which you suppose to be delicate sea-weed—you will probably see (with a magnifying glass) that is it an assemblage of horny cells or hollowed vessels, on a stem of similar structure; and if the animal be alive, each cell is tenanted by a little creature of most beautiful form, and most active habits. All polyps are not thus clustered, but many are, and the distinctive characters of the class are the facts of their being *fixed*, either solitarily or in masses, by a stem, and their possessing arms (tentacles *e. g.*), with which they seize their food."

A *Zoöphyte*, then, is an aquatic animal attached to rocks or other substances in the sea or in rivers. It is the marine species, however, that we shall take into consideration here.

These *Zoöphytes* or *Polyps*, as they are also called, are of three kinds, viz. :

1. *Hydraforms.* Where each animal is solitary or joined to a stem, common to a great many individuals ; and the stem or "polyp-house," as it is called, is horny and hollowed like a reed.

2. *Asteroids.* Here the polyps are united in family like those of the last division, but the "polyp-house" is fleshy, and the polyps open on the surface like a star with six or eight rays.

3. *Helianthoids.*—The polyps are here single or attached temporarily or permanently to their dwelling places in the rocks. Some few being "free," and some, *e. g.*, corals surrounded with a crust of hard lime—their tentacles (or arms) open out in a circular form like the rays of the sun.

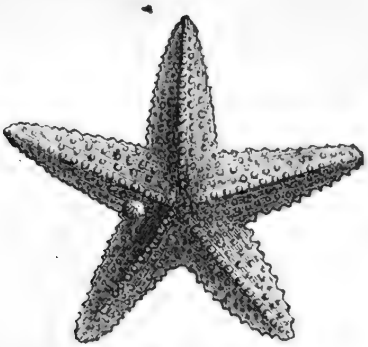
All these three orders may be represented in an *Aquarium ;* but the animals belonging to the last, *Helianthoids*, are those that we shall be most likely to find, and are, also, the most ornamental. The *Zoöphytes* have a curious property of bearing to be cut or torn into two or more portions, without either portion dying therefrom. If we sever a limb from the body of almost any other animal, it will not become a separate creature ; but if we cut a *Zoöphyte* in two, each piece will live and become an independent and perfect existence.

This curious property of bearing dismemberment, or severance, without any great inconvenience, can be proved, if we wish to experiment with some of the fresh-water polyps, which are more easily procurable to many persons than the marine *Zoöphytes.* In most brooks and ponds we find adhering to stones, plants or dead leaves and, indeed, to any

secure foothold, numerous minute creatures which appear, when viewed with the unassisted eye, like miniature flowers, either of a brownish or, more commonly, of a green color, the latter of which is called *Hydra viridis.* It is called *Hydra,* on account of some fancied resemblance to the many-headed creature of mythology bearing that name. The fresh-water *Hydra,* however, has really but one head, and the other members that appear like heads, are but the arms or tentacles that I have spoken of before, arranged in a circle around the mouth. This green species of *Hydra* has been called *viridis,* on account of its green color, and was supposed to have the power of stinging other animals; but this is a mistake, as we shall see, when we come to consider the sea Anemones. If we should take one of these curious little *Hydras,* and cut it transversely through its body, we shall find, that the part that bears the head will form for itself a new body and foot; while, from the other portion which is but a body and foot, will grow a new head and tentacles. We can also cut a *Hydra* longitudinally in several pieces and each portion will supply itself with the wanting parts, and become a perfect animal. We can turn it inside out, and the part that was the lining of the stomach will become the exterior skin or *cuticle;* and the *cuticle* will take upon itself the offices of the stomach. And like experiments can be made on sea Anemones with similar results, but they are, as a general rule, more tender than their fresh-water relations; and, indeed, there are many of the species that will certainly die under the operation; for we find that on separating them from the rock to which they are attached (if we are not very

careful to avoid injuring, in any way, the tender foot of the animal), any wounded part will decay, and finally kill the creature.

There is a class of animals nearly related to the Anemones, termed *Echinoderms*, of which several species may be introduced into an *Aquarium*, and many of which are to be obtained on our seaboard; as, the curious *Echinus* that looks like a pin-cushion beset with pins, or—taking another figure for example—appearing to be a near relation of the hedgehog. Starfish, of which we have one very common



Star-fish.

species, the *Asterias rubens*, or common five-finger, may be introduced into an *Aquarium;* but they have an unpleasant propensity of rending themselves apart—that is to say, in confinement they will tear off their rays one by one, leaving them behind them, I have seen one ray, attached to a body, travelling on, having left the other four behind fixed to the glass side of the tank.

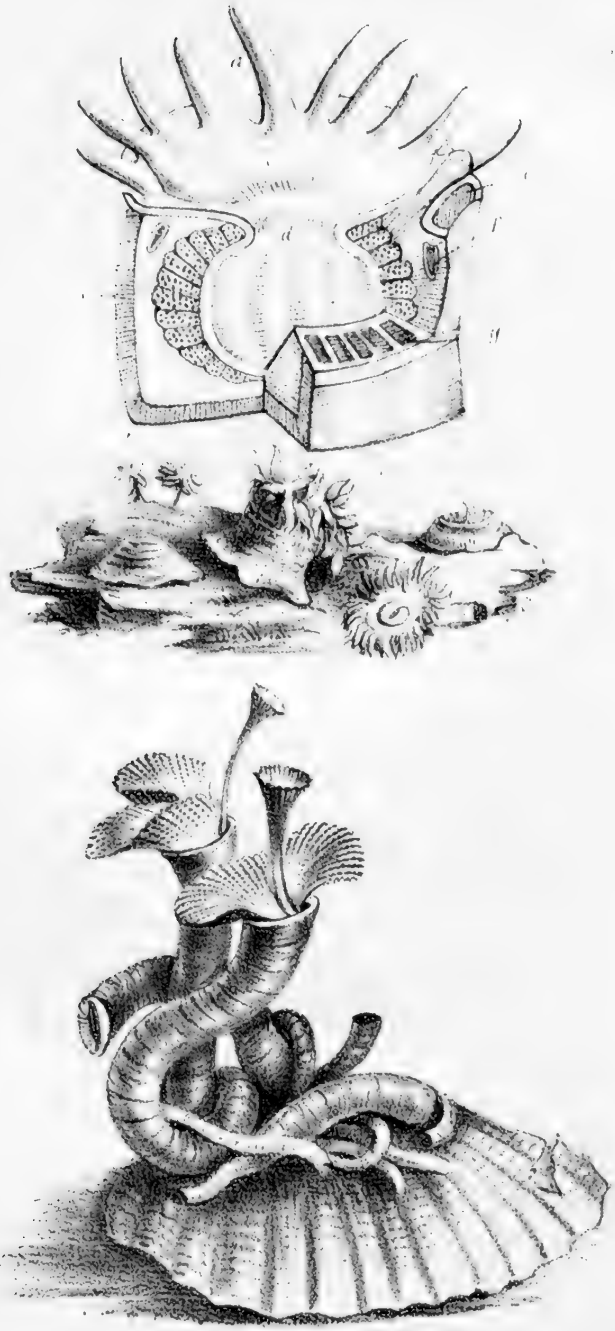
The gorgeous *Serpulæ*, of which there are to be found several species on the New York coast, may be placed with advantage in our *Aquarium*. They are curious creatures, living in tubes composed of lime, of a serpentine form, and attached to stones. When these tubes are watched, and everything is perfectly still, we shall see the animal project an instrument of the form of a trumpet, which is used to stop up the entrance to his house. Next comes two combs of bright scarlet tentaculæ, which are used to secure its prey; but let us make ever so slight a movement, and, at once, all disappears within the tube. There is also a species which has its combs of hairs of an orange hue, and its long funnel of a bright red color. This species is very common, and is called *Serpula contortuplicata*. (Plate X., Fig. 3.)

An Anemone (so called from some fancied resemblance to the flower of that name, though it is more like a passion-flower) is in appearance, when closed, a mass of flesh, of a somewhat hemispherical form, and varying in size from that of the head of a pin, to five or six inches across, (when open). When the creature is hungry (which is nearly always), it spreads its arms out in all directions; and then, the Anemone is a splendid sight—being of all shades, from a pure white to dark brown, through different shades of red, scarlet, grey, green and orange, and in a few kinds, blue.

It is difficult to give to a person who has never seen an Anemone, an idea of its form and appearance when expanded to its utmost. Imagine, however, a glass tumbler turned bottom upwards, and having around the edge of

the bottom a row, of from fifty to two hundred or even more fingers, disposed in two or three rows, and in the centre of the bottom of the tumbler a slight elevation, with an opening in it—this will give you some slight idea of the form of our hero; but as to his color, semi-transparency, and graceful form and movement, no description can do justice to it!

The tumbler, in our example, represents the "body," the flat bottom (which is turned upwards) the "oral disc;" and if we were to stretch a piece of paper over the mouth of the glass, this would represent the "base;" the fingers around the disc are the "tentacles," and the opening in the centre of the disc the "mouth." We now know the principal parts of an Anemone. But let us go still farther, and examine his interior economy. I have given (Plate X., Fig. 1), a section of a full-grown specimen of *Actinia mesembryanthemum*. A portion has been removed, so that we can see the interior arrangement of the organs; *b*, is the outer skin, or cuticle, covering the whole animal; *a*, *a*, are the tentacles, placed on the edge of the oral disc in rows, and each having an opening at the pointed end, through which water is drawn into the interior of the animal for the purpose of expansion, and which carries along with it numerous minute animalculæ, serving as food to the Anemone; so that he feeds, not only by means of the mouth, but through the openings at the ends of the tentacles. The oral disc extends from the base of the tentacles to the mouth, *d*. Below *d*, is the stomach, which is corrugated; but you need not cut your Anemone open to see the interior of his stomach, as he will certainly very often turn



himself inside-out, and so give you an opportunity of inspecting it at your leisure. At *e*, are coiled up in separate chambers, certain organs, that, until lately, were supposed to be, and therefore, were called the "ovaries." Sections of the chambers in which they lie are given at *g*; they communicate one with another by means of openings, represented at *f*, and with the tentacles at *c*. The true ovaries, however, have been discovered by Mr. G. H. Lewes, who thus leaves the function of the convoluted bands *(e)* a problem to be solved; as the true ovaries lie under the convoluted bands by which they are completely hidden.

If you incommode "daisy," the popular name of a species of Anemone—and the same fact may be observed in the common brown American species (*Actinia marginata*)—with your finger nail, he will shoot out from nearly every part of his body numerous white seeming threads at you. He uses these for the purpose of defence, as well as to secure his prey. Cut off the end of one of them never fear, he will not mind it—and put it under a microscope, and it will present the appearance of a cylindrical white cord, moving freely by means of multitudes of "cilia" or hairs, with which it is fringed, and composed of an outside membrane to which the cilia are attached.

When the Anemone recovers his temper, he draws back the threads into his body. As to the true use of the "spike cases," as the cells that contain these threads are called, I can give the reader but little information. It has been found, however, that they have not the stinging power that was once attributed to them. Many naturalists believe them to be weapons of defence, and that the spike with which the

end of each of them is armed is used in killing the animalcules, crabs and molluses, on which the anemone feeds, as well as in warning off any hostile intruder.

The species of anemones that are found on the American coast are numerous, but have not been sufficiently studied to permit me to give a list of them. Le Seur, in volume first of the Transactions of the Academy of natural sciences of Philadelphia, describes two species found on the coast near New York and which he calls respectively *Actinia rapiformis* and *A. marginata.*

Actinia rapiformis is described by Le Seur as follows: "*Tentacles,* short, cylindrical, equal, disposed in four rows. *Body,* fleshy, very contractile, assuming different forms and frequently those of a turnip and pear, the former of which it resembles in its dull, opaque white color; when contracted it is of a sub-globular form. The young are more transparent than the old and are sometimes of a darker color. It is found in the sand of the United States coast and raises its head above the common surface for the purpose of displaying its tentacles. When contracted in its habitation, it is concealed below the surface." Its dimensions are one inch and a half across, by four to five inches in length. I am of opinion that this must be the same species that is found so abundantly at Hurlgate just above New York city, though Le Seur's specimens came from Egg Harbor, New Jersey.

Actinia marginata (Plate X., Fig. 2) has eight or nine rows of tentacles, which are short, slender, equal, placed on a large expansion, the plaits whereof present ten or twelve large lobes; the border of the upper extremity of

the body is large and incloses the tentaculæ when contracted, which are disposed in quincunx order and smooth-pointed, and of a pale reddish color; the mouth is plaited. The animal when unfolded presents a branchial disc, the color of which and of the body is burnt terra-de-sienna. Its diameter and height are about one and a half inches. Le Seur found it in Boston harbor in crevices of rocks below *fuci*; but I have received it from Newport, R. I., where it seems to be very common. This species sometimes will project its "spike-threads" without any seeming provocation.

I am not certain whether I should refer a species that I have seen which came from Newport, R. I., to Mr. Gosse's "Plumose Anemone," the *Actinia dianthus* of other writers. It answers to the descriptions and resembles in color the one that serves as a frontispiece to Mr. Tugwell's "manual;" however, as he only enumerates six varieties and fawn-color is not among them, I must still remain in doubt.

To the American species of actinia, mentioned above, I have to add five which W. Simpson obtained at the Island of Grand Menan, off the coast of the State of Maine, namely, the English species *Actinia coriacea* and *dianthus*, Le Seur's *A. marginata* and three new species, which he names and describes as follows:

A. carneola. St.—Very small, about $\frac{4}{10}$ in. diameter, mouth protruding far upwards on the broad disc, on the edge of which are the tentaculæ, alternating in two approximated rows, there being eighteen in each row. On the disc, above the base of each of the larger tentaculæ, are two prominent white spots, one above the other; while the lower tentaculæ

have one spot at their inner bases. This spot is of a light flesh color. Dredged from 35 fathoms, N. E. shore.

"*A. obtruncata.* St.—Body short, with a broad flat disc, on which, between the small mouth and the margin, are placed the tentaculæ; which are short, very blunt at their extremities, as if cut off, usually equidistant, not very numerous, and arranged alternately in four or five very indistinct rows. Sides, smooth and clean, with a few porous warts, which can seldom be perceived. Color, dark purplish, lighter on the disc, with broad streaks of crimson, which meander among the bases of the tentaculæ.

"*A. sipunculoides.* St.—Body greatly elongated, covered with a thin brownish epidermis, with eight narrow longitudinal white lines, dividing the body at the anterior extremity in eight lobes when contracted. Tentaculæ twenty, short, curved, and with blunt extremities."

For further information concerning these Anemones, together with a list of the other *Invertebrata* of Grand Menan, the reader is referred to volume six of the Smithsonian Contributions to Knowledge for 1854.

Dr. Leidy has given a paper in the third volume of the new series of the Journal of the Academy of Natural Sciences of Philadelphia on the Invertebrata of Rhode Island and New Jersey, in which a few new Anemones are mentioned, the descriptions of which I copy below.

"*Actinia marginata.* Var. *ambrea.*—Two or three lines in diameter, of a translucent, ambreous appearance.

Var. *salmonea.*—One inch in diameter. Bright salmon color. When irritated, it ejected jets of water from large pores of the body, a phenomenon I did not observe in the

more ordinary variety. *A. neglecta.* Leidy.—Body, when closed, obpyriform, or shortly cylindrical; when expanded, cylindrical, about an inch in length by one fourth of an inch in breadth; smooth, translucent, olive green. Mouth, elliptical, with the lip composed of six greenish-white lobes. Tentacles, numerous, up to half an inch in length, brighter olive green than the body. In the mud of a sound in the vicinity of Atlantic City."

The most of the Anemones found on the coast of and adjacent to New York have not been yet studied; and I shall here leave them and conclude this chapter with an extract from an article published in the third volume of Chambers's Edinburgh Journal, entitled "An afternoon among the tenants of the deep"—which speaks of the Anemones as follows: "They are greedy creatures, and the fishermen have reason to dread their ravages, for they sometimes get into their crab or lobster pots, and will wind their tentaculæ round a fine crab or lobster, or whatever they may lay hold of, and suck out every particle of its juices, casting out the empty shell from their devouring maw, when they have absorbed the whole of its contents. In some seas, these creatures grow to so enormous a size as to be able to inflict serious injury; they have been known to seize a man; and an instance was lately told me by a young Indian officer, of a friend of his, who, when bathing, had his thigh taken hold of by one of these horrible creatures, from which he sustained severe injury; and was released only by having the animal cut from him piecemeal. Such dangers, however, do not exist in our seas, nor could they be anticipated from the lovely little actiniæ in the tanks."

CHAPTER XIV.

GENERAL MANAGEMENT OF THE MARINE AQUARIUM.

Feeding Fish—Fighting for Food—Crabs' mode of Eating—Rapacity of Minnows—Overstocking—Hermit-crabs die first—Remedy for Overstocking—Scavengers—Aërating the Water—Fountain—Net—Filtering the Water—Artificial Sea Water—Amount of Plants necessary—Opacity of the Water at certain seasons—Remedy—Evaporation.

A FEW hints as to the management of a marine collection may not be unacceptable to the reader, and as they are the result of much labor and some experience in this branch of science, I trust they will, if attended to, be useful, and assist many in the keeping in order of these beautiful ornaments and sources of instruction.

In feeding fish in a marine tank, the same precautions must, of course, be taken, as when so feeding the fresh-water animals. Not only the fish, but the other creatures that we keep in a marine *Aquarium*, must be fed, or else we shall find the stronger preying upon the smaller and weaker; thus, crabs, lobsters and shrimps are inclined to attack the fish, but not the Zoöphytes. Some authors have said, that Anemones will eat crabs and shrimps; but a writer in Blackwood's Magazine, for January, 1857, when speaking of these creatures, in an extremely interesting article, on "New facts and old fancies about sea Anemo-

nes," mentions that he several times attempted to force them to catch and devour crabs and shrimps, but in no single instance succeeded.

When I feed the animals in my tank, it is a continual warfare between different species; between the stronger and the weaker, until every morsel of eatable matter is consumed. Just now, I caught two flies, and crushing them between my finger and thumb below water, so as to remove the air that the bodies might contain, I brought one down with a slender rod of wood near to an anemone, intending it for him, as he cannot travel in search of food, but like a child, requires to be fed; I had got it nearly to his open and expectant arms, when snap, presto! in dashed an impudent diminutive minnow and bore off the prize, but which was too large for him to swallow all at once. Now began the battle between the ten or fifteen minnows in the tank for the dainty bit, one of them "bolted" (I use this word for want of one that would better express the velocity with which it was engulfed in his capacious jaws) the first of the flies. I introduced another, and this time the head was torn from the body, and borne away in the jaws of a juvenile victor minnow, who did not measure above three-quarters of an inch from head to tail; he found, however, the eyes too tough for his young gums, and so cast it loose again, when it was taken hold of by an enterprising shrimp, who fell to, heartily, upon it. In the meantime, the other part of the fly having fallen between the glass and a stone, escaped the notice of the minnows, but was taken possession of by a large shrimp, who soon had to relinquish it to a small

crab who having observed, from a distance, a commotion in that part of the tank, seemed to understand that something was going forward that required his especial attention. He seized the fly, and began systematically to tear it to pieces, holding one piece in his right hand claw, whilst the other portion was conveyed to his mouth, to undergo the process of mastication. With his left claw he kept at bay—by snapping at them now and then—a shoal of minnows and shrimps who seemed to want to dispute his right to the food, and thought perhaps that theirs, by discovery, should have been respected, but in the little world of the *Aquarium*, as in the great one outside, the right is with the mightiest, and possession is nine points. The crab, having satisfied himself with the edible portions of the fly, left the shell to the shrimps, who turned it over and over, looking in vain for a remnant. Another fly was now thrown in, which a miserable sized minnow attempted to swallow whole, but failing in so doing, flew about the tank with the head and wings protruding from his mouth, and a host of anxious relatives and friends following in his wake, putting one in mind of a feeding time in a chicken-yard, when a chick of a brood will attempt to swallow a large piece of bread, and failing so to do, will run about, the others after her with outstretched necks and seemingly protruding eyes, expectant for the morsel. The poor little minnow turns and doubles, seeking in vain to elude the hungry many, until at last, one swifter than the rest dashes forwards and wrests the fly from his mouth, and immediately engulfs it in his stomach, which seems to be made of some elastic material, for it is difficult to give

a minnow more food than he will swallow—and even when he can put no more into his stomach, he will fill his mouth and retire to some secluded spot to sleep off his meal.

There is one thing that is very likely to happen to a *tyro* when stocking his tank, and which he will find to be ruination to the well-being of an *Aquarium;* and that is, overstocking. This is more likely to happen to a marine collection than a fresh-water one, as we are apt to place everything that we pick up on the shore in our tank, and so, at last, we go beyond the limit that nature has assigned for the proper balance of animal and vegetable life in the ocean, river and pond. When this happens, we observe our most tender animals show signs of uneasiness, and, at last die; the hermit crabs, being those that soonest sicken and die, and if not removed, their bodies soon foul the water and cause the death of the other creatures in the tank. All the other inhabitants of our *Aquarium* may appear in a healthy and flourishing condition, except the poor hermits, and when they crawl out of their shells, braving the minnows and other fish, we may be sure then, there is something wrong, and that the collection requires attending to. In such a case, it is best to see if the tank be overstocked, and it is surely so, if it contain more inhabitants in proportion to its size than the one I have spoken of in chapter two. Then we must remove some of the fish and other creatures. If this does not remedy the evil, and things still wear an unpleasant look, it is best to remove and change the water; and, indeed, sometimes to begin with a new stock of sea-weeds.

The molluscs in the marine collection do not seem to

be disposed to perform their duty of cleaning the glass, therefore, we must assist them; and for this purpose, as I have before mentioned, I have found a good instrument to be a piece of sponge attached to the end of a rod of wood, with which we can scrub the glass to our satisfaction, until it assumes a clearness that allows us to observe the habits and motions of the contained animals. The glass will sometimes, if neglected for any length of time, be found to have young shoots of *Ulva or Enteromorpha* growing upon it and which sometimes the sponge will not sufficiently remove. We can then use a brush, such as a tooth or nail brush, for this purpose.

Often, if we happen to have several dull days without sufficient sunshine, we shall observe the plants and animals to assume a sickly appearance, the fish coming to the surface to breathe, and everything looking bad; and things will continue to get worse if not attended to. The water will, on such occasions, need aërating; and this can be done either by taking some out with a pitcher and pouring it back, or, still better, by having a contrivance which I have used for the purpose for some time. It consists of a chemist's bell-glass that has a hole at the end, usually occupied by the knob, into which we insert a cork that is perforated with a hole and has a piece of glass tube fixed in it. This glass tube is turned downwards as the glass stands at an acute angle and is drawn out to a fine point, so that it allows the passage of only a small amount of water. We now invert the bell-glass, and, suspending it over, fill it with water removed from, the tank. The water is at once forced, by

the pressure of the atmosphere, out at the fine orifice and forms a *jet d'eau*, which can be directed to any part of the tank. From passing thus in several fine streams through the air, the water gets well aërated; and if the bell-glass be sufficiently large, our miniature fountain will continue to play for an hour or more.

It will be found useful to have as adjuncts to our *Aquarium* a net about three inches in diameter, made by stretching a bag of fine bobbinet over a wire ring and attaching it to a wooden handle; a pair of long wooden forceps will also be found useful, both of these serving to remove dead fish and portions of sea-weeds that would otherwise decay and overturn the economy of our collection.

Filtering.—When sea water is used, and, indeed, sometimes it will be so with the artificial article, it will prove muddy or not clear from some minute floating bodies that it would take days to deposit. If we do not wish to wait so long, we can resort to filtering in order to render the water clear; and this is done by suspending over the tank a perfectly clean clay garden flower-pot, which has a portion of sponge thrust into the hole, and, over the bottom, a layer of powdered wood-charcoal. If the water is allowed to pass through the charcoal and sponge, it will be found to be perfectly clear and well aërated at the same time. As Mr. Hibberd remarks, "With the river tank, the simplest way of reviving exhausted stock is wholly or partially to change the water; with the marine stock, such a change is not easy, and the filter comes more legitimately into use, as already

remarked, the necessity for aëration marks error in management, except when you have stock for which no proper receptacle is at hand or any such *special* contingency."

When we use the artificial sea-water and, for the purpose of "seasoning" it, place in it *Ulva* and *Enteromorpha*, these plants, after a time, often become light-colored and, at last, quite white, which is a sign of death and decay, and should be at once attended to by removing the plants and replacing them by others. When the water has become well seasoned, we shall not be so likely to see this happen, unless something else in the tank be out of order. If, however, any of the red *algæ* be introduced before the proper time, that is to say, where the *Aquarium* has not been in vigorous action some time, they will be sure to decay and color the water of a brilliant red, which must kill all the animals, beginning with the hermit crabs, who are always the first to show signs of something being wrong in the economy of the collection. One of the first signs of decay in the red seaweeds is their turning of a bright orange in spots and near to the edge.

As to the amount of plants necessary to aërate the water for a given number of animals, it is very difficult to present anything that may be laid down as a rule on that point. The knowledge required so to adjust the vegetable to the animal life in order to balance them, can only be learned by practice. We should always be certain of putting in enough vegetable matter. Some writers pretend to lay down a rule for its introduction, saying that one plant is sufficient for two animals with-

out informing us whether the plant be large and the animals small, or *vice versâ*. One full-grown plant of *Ulva* or *Valisneria* will give off enough oxygen for two or three minnows; but one plant of *Enteromorpha* or *Lemna*, will certainly not supply enough oxygen for one fish, however small, be he even a stickleback of half an inch long.

As I have remarked before, at certain seasons of the year, the water of the *Aquarium* will become opaque from myriads of the green *spores* or seeds of the *algæ*, and to get rid of these, Mr. W. A. Lloyd recommended a removal of the water from the tank and shutting it up in a dark place, where the *spores* cannot get the light necessary to their growth and, therefore, die. I have sometimes found that if there be no fish in the tank, this green cloud will settle to the bottom and, after a while, supply us with a harvest of young plants of *Ulva* or *Enteromorpha*.

When putrefaction has set in among our live stock, it will progress with alarming rapidity, and in a few hours the stench from the tank may be so strong that it cannot be borne. The best thing then to do will be to remove all stock that still remains alive, and, washing it in a pail of clean sea water, place it in a jar or glass dish to save it. As we may be some way from the sea, we shall, of course, wish to save the sea-water if we can, for the water itself never decays, it is only the particles of animal matter diffused through it that are causing the trouble. Mr. Gosse recommended putting the water that is in a vessel, into some out-

house or place where the foul odor will not be troublesome and allowing the decay to go on, which it will do, until all the animal and vegetable matter has gone off in the form of gas and the water is left quite sweet.

Evaporation is continually going on from the water in an *Aquarium*, but it is only from the water, the salt being left behind; and, therefore, we must replenish it from the tap or spring with clear fresh water. To know the exact quantity to be put in (and this is an important point) we may have some mark on the glass side of the vessel, as a piece of paper fastened on, or we can use a hydrometer like that I have described in chapter nine.

The cloudiness of the water may be occasioned by another circumstance, and that is from the increase of minute animalculæ; but this fact need not frighten us, for they are the natural food of our fish and zoöphytes, who will, therefore, require the less feeding.

These few facts will, I hope, aid the reader in the proper management of a marine *Aquarium*.

CHAPTER XV.

COLLECTING OBJECTS TO STOCK THE AQUARIUM.

Advantage of collecting Objects to stock an Aquarium for yourself—Sea-side Equipment—A Visit to Hurlgate—The Tides—Danger of treading on the Fucus—Crabs under stones—Barnacles troublesome to Naturalists—Botryllus—Eolis—Eolis not a Nudibranchiate—First Rock-pool—Anemones—Sertulariæ—Multiplicity of Life in the Ocean—Corkscrew Coralline—Birds-head process—A mile of Star-fish—The Whelk—Fresh-water Stock—Visit to Union Hill—Anacharis Canadensis on New York Island—Sunfish, etc.

Although objects for the purpose of stocking the *Aquarium* can be now purchased in New York city, and may soon be for sale in other of our large cities, still, one of the chief pleasures incident to keeping an *Aquarium* is the collecting of plants, and securing animals, and introducing the same into it, while the healthy exercise which such employment gives, is one great recommendation in this modern fashionable pursuit.

Let us suppose that our reader, "a citizen of credit and renown" in New York, has procured a tank of such form or dimensions as is best adapted for the position in which it is to be placed, and wishes to obtain plants and animals to put in it, so as to constitute an *Aquarium;* we will also suppose it to be intended for a marine collection; how shall he and I equip ourselves, and, when equipped,

where shall we proceed in order to obtain the necessary materials to constitute the stock?

You and I, reader, will go to the seashore for wonders to bring home and to place in our crystal prison, and there admire in our leisure hours. So first, if you please, we will dress ourselves in a rough suit of clothes—never mind if they be a little the worse for wear—we are not going to promenade Broadway, but to walk where nobody is going to look at us, save the sea-nymphs (if we are so fortunate as to stumble on any of those creatures—and when we do, we will bring them home and put them into our *Aquarium*); therefore, let the clothes be old, and the boots be heavy and strong. A hat is apt to blow off, so we will provide ourselves with tight-fitting caps. As for the implements that we intend to take with us, it is all very well for writers to describe complicated zinc-cans and leather-sachels, with their various internal arrangements, which can be used on such occasions; but these will be of no service to us, who are going to start off at a day's notice and have neither time nor inclination to encumber ourselves with such machinery of action. We'll take with us A BASKET, containing *a tin-can*, with a cover—it should hold about a gallon; *three glass bottles*, with wide mouths, holding respectively a pint, a quart, and half a gallon—or they may be smaller, if we are cramped for room. I have sometimes found one of the capacity of a quart sufficient, but on this point the collector can judge for himself, after having been out once; *a geologist's hammer and a stone chisel*, one of the kind denominated technically, "cold chisel," having a sharp-cutting steel edge. These implements are indispensable, as

we shall find, when procuring anemones and some of the algæ ; *an ivory paper-knife and a small net*, about six inches across, and attached to the end of a pole, six feet in length. This net is to be used for the purpose of capturing fish, crabs and other active creatures.

The meshes of this net should be about one-third of an inch across or of the dimensions of those in what is termed "shrimp net." If we are going particularly for anemones, we shall find it convenient to take an iron crowbar, as Mr. Tugwell recommends in his "Manual," dispensing with the "able-bodied man" therein mentioned, as we shall find it healthy work, learning to use the crowbar ourselves. However, as we are supposed to be going after general stock for an *Aquarium*, we will leave the crowbar at home for the present.

Thus equipped we start for the shore, wherever we can touch it. Let us for a moment suppose that we decide to take the city cars of New York, that run up the Third Avenue to Yorkville, and, jumping in, pay our fare, six cents—little enough for a journey of five and-a-half miles, as it is, from the City Hall. And now we are at Fifty-third street, so let us stop, alight, and look about us. We walk to the East River, and, descending the rocks, come upon a shore, which, supposing that we have chosen our hour properly and the tide is out, will yield us several treasures for our *Aquarium*. As we wish to go to the shore when the tide is lowest, we should choose the autumn or spring, as, at those seasons, the tides reach their greatest declination ; and, then, certain points of the shore will be uncovered, which at other times cannot be reached. It is

always best to gain the point of shore we intend to search about half an hour before lowest tide, and follow the water down, thus securing many creatures that otherwise would, very soon, make their escape into the water.

Take care how you step upon those flat rocks, formed of gneiss and covered with a dark olive-colored seaweed, called bladder-wrack (*Fucus vesiculosus*), for it is a very treacherous and slippery standing-place, and if you slip, perhaps you will be thrown on some sharp, hidden edge of a rock, or have your leg twisted, or, indeed, broken by being forced suddenly between the upright masses. Do not step upon that loose-looking mass of weed, for it only covers a hole, which, most likely, is pretty deep, and would be dangerous to fall into ; besides, it may contain something that we want. Instead of stepping on it, let us turn up the *Fuci*, and we shall find a little inland sea, termed a rock-pool. Hallo ! there's something wriggling in it ; a good-sized eel, by all that's fortunate ; where's the net? We'll have him and put him into our can, with some water.

Turn over that stone. See ! away scamper four or five crabs. We won't take them, as they are extremely voracious, and are not so pretty as our friends, the "hermits," that we shall get anon.

What are those little white cones covering the rocks? Those are *Balani*, barnacles, or sea-acorns ; and if we take some home and place them in a vessel of sea water, after a time we shall see them open and project their tentacles in search of food, and the action of which reminds us of a fisherman throwing his nets—it being done with a swinging motion. They are pretty creatures, but will not live long

in the confinement of an *Aquarium;* they soon die, and, decaying, foul the water; and, inasmuch as they generally keep their shells closed, we may not discover their death until it is too late and the damage is done and they fall off the stone. They seem to require the motion of the water, and that they should be left high and dry by the retreating of the tide, twice every twenty-four hours. It is this species of barnacle, along with another, that attaches itself to the bottoms of ships, and accumulates in such large quantities as very seriously to impede a vessel's motion through the water. These same fellows, the barnacles, with all the interest that attaches to them, are one of the torments of the searcher on the shore, as he will find, if he happen to slip on some fucus-covered stone, and, stretching out his hand to save himself from falling, happens to lay hold of a stone covered with barnacles; for he will, most assuredly, get his hand cut and torn in several places as if with penknives, but really with the many shells of these troublesome multivalves.

Now turn over that large stone in order to see what treasures are hid beneath it. Ah! it has slipped through your hands because it is covered on the underside with a slimy coating which will bear nearer examination. It is a mass of semi-solid jelly, adhering closely to the rock, and of about the thickness of half an inch. As to its colors, are they not brilliant? See—there is some with a groundwork, nearly white, with little black stars sprinkled all over it, while we see some black with white stars, like the sky at night. Turn over another stone and we shall find it orange, yellow, leek-green, or of a deep ruby, with

all kinds of colored stars, white, black, red, yellow, green, orange; but all the same thing—an assemblage of animals—in fact, what is called a composite animal, and named *Botryllus*. Each one of those stars is an animal; and what is more, an animal possessing a shell, and belonging to the same family as the whelks or *Fusi*, although its shell is not of so pretty a form as those appertaining to the mollusca that we see crawling over the shore. The shell in the *Botryllus* consists of separate portions, called *spiculæ*, which are distributed through the fleshy matrix. The natural history of the *Botryllidæ* is very little known; but now that we have *Aquaria*, in which they may be kept alive for some time at least, we may hope to hear of some adventurous naturalist turning his attention in this direction. You will find the *Fusi* and stones in some places nearly covered with these *Botryllus*, so as to conceal their forms, and rendering it difficult to handle either stone or fucus.

See! what is that on yon stone, looking somewhat like a small garden-slug with a bunch of pink feathers up on his back? It is an *Eolis*, and those beautiful pink, club-like projections are not lungs or "*branchial papillæ*, as they were for a long time supposed to be; but branches of the intestine, as Mr. G. H. Lewes has proved and shown in his extremely interesting "Sea-side Studies," lately published.

The *Eolis* must, therefore, be removed from the order of nudibranchiates, or animals with naked lungs; and Mr. Lewes proposes to construct a new order for it, to be called Abranchiate. The pretty little *Eolids* will live

in confinement, and look very beautiful in an *Aquarium;* but we cannot place them in a tank with anemones, as they would nibble our *actiniæ* terribly. Let us go a little farther on. One of our party, a little in advance, is calling out for us "to come and see something," in a voice that plainly says, that the "something" is worth seeing; and now reaching him, we acknowledge that it is. Here is a genuine rock-pool, the gold mine of the naturalist. Let me try and give you some idea of this natural *Aquarium*. It consists of a basin formed in the rock, about mid-way between high and low-water mark, and is from three to four feet long, and two feet wide, by a foot deep. All around its edge the *Fuci* hang down into the water, and almost all the rest of the sides and bottom are covered with the *Cladaphora Ulva, Grinnellia Ptilota* and other plants, whilst eels and crabs sport about in the clear liquid, associated with the funny little "water-fleas" and shrimps. See! there is a large shrimp, clear and semi-transparent as if he were made of glass, looking very like a ghost of a lobster come up from bottom of the mighty deep to gaze on us, and gaze on us he does with his curious eyes set on the ends of stalks; but let us even hint at such a thing as catching him, and he is off among the seaweed. Attached to the bottom, at different points, are five or six beautiful white and orange-colored anemones, which, when we essay to detach them, shrink to nothing but a minute hemispherical mass of flesh. But do not let that disappoint you, as, if we turn over some of those mud-covered stones near low-water mark, we shall find plenty more of them,

and, after carefully washing off the mud, we can take home a stone which, when it is placed in our *Aquarium*, we shall find to bear, perhaps, a dozen small but brilliant orange-colored anemones.

If we examine the tangled fucus that hangs in such profusion from every stone, we shall find it bears immense quantities of small branches, which are the dwelling places of a minute zoöphyte that expands a circle of tentacles like an anemone, but perfectly transparent. It belongs to a family called *Sertularice*, and will well repay investigation. Within a radius of six feet around us, there are, probably, millions of these little creatures. And yet, each of these is covered with hundreds of minute plants of the order of *Diatomaceæ*. A good example of the multiplicity of animal and vegetable existence in the ocean.

We shall, in all probability, find upon this shore, specimens of the pretty little "Corkscrew Coralline," as it called but it is another zoöphyte, and, therefore, not a coralline, as that name is now restricted to an order of marine plants. This little creature, or rather colony of creatures, looks like a tree in which the branches are arranged in a spiral form around the trunk, and Mr. Lewes speaks of it as follows: "The stem is twisted into a corkscrew shape, sufficiently remarkable to attract attention in rock-pools or in tanks. On examining it attentively, it is generally seen to be furnished with a number of processes resembling vulture-heads—one beneath each cup—having two mandibles, one fixed, the other movable by means of two sets of muscular fibres, visible within the head; and these

mandibles keep up an incessant snapping, which occasionally entraps some worm, or minute crustacea, in an inexorable grasp. Very interesting it is to watch these birds'-heads snapping with vague vigor, while *above* them the animals, to which they can scarcely be said to belong, are protruding from their cups; for, be it noted, the bird's-head does not form part of the animal, but issues from the stem on which the colony of animals abides; as if a gentleman residing in the parlor kept a watch-dog chained to his area-gate." This curious zoöphyte is thrown up in large quantities in the dead state during the autumn at Glen Cove, on Long Island, which place the reader will do well to visit if he wish to see some of the "wonders of the shore," for there he can get minnows and other fish in abundance, together with hermit crabs by the peck, and starfish by the cart-load—yes, literally by the cart-load; for, during the month of September of the year 1857, I saw at least a mile of the shore covered down far below low-water mark with this beautiful animal, which, however, is no favorite with fishermen, as they will often destroy large quantities of oysters.

The Common Whelk (*Buccinum obsoletum*) is common upon nearly all our coasts, for instance, at Greenpoint and Glen Cove, and at some parts of Hurlgate shore.

The *Fusus cinereus* is found along with the *Buccinum*, and the *Pecten*, with his metallic blue eyes, is also to be found at Glen Cove, together with living *Anomias* during the autumn.

If we wish to obtain fresh-water stock, we can cross over any of the three city ferries which take us to Hoboken; and, then, jumping into one of the omnibuses that stand

near the boat-landing, allow it to take us to Union Hill, which is on the heights beyond Hoboken. On the way up we get a beautiful view over the marshes of Hoboken and of New York. Getting out at the little village of Union Hill, where the omnibus turns off to the right, we cross over to the left side of the road; and here we find a little brook that flows down the hill across the road and into the Hudson River at Weehawken Bay.

In this stream we find some useful plants, as *Potamogeton pusillis*, water-cress and one or two others.

In some of the quieter parts of the stream, *Chara vulgaris* is to be found. Snails are to be obtained here of the genera *Lymnea*, *Physa* and *Planorbis*, besides a fresh-water clam of the genus *Cypris*. In the little forest of cedar trees, a short distance farther back on the other side of the road to Jersey City, are to be found several fresh-water plants, as *Myriophyllum*, etc.

I have obtained *Anacharis Canadensis* in considerable quantity, along with snails and caddis-worms in a little stream in Jones's Wood on New York island. In the stream on Union Hill tadpoles and caddis-worms can be taken. It is only rarely that I have caught newts and black-nosed dace there. By the way these latter little gentlemen are excellent for an *Aquarium*.

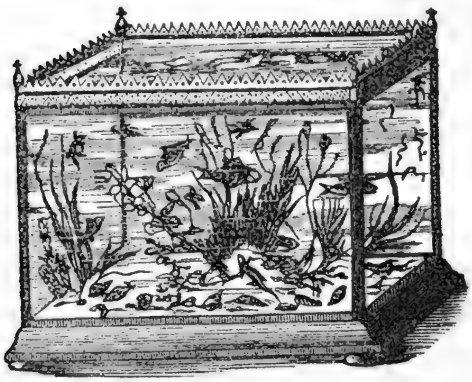
The large sunfish I have secured at Crystal Lake on Staten Island and at Glen Cove, while at both these places I have also found the small black-eared sunfish. Minnows are to be caught along our coast in bays, as at Glen Cove, in large quantities, and also in the Morris Canal in New Jersey.

Callitriche verna I have obtained along with a few other plants at Hastings on the Hudson, about twenty-one miles from New York City. The *Ceratophyllum* is to be procured at Oyster Bay, Long Island, and in Crystal Lake (Staten Island) where the white water lily and *Brasenia* are also found with *Nitella flexilis*.

Duckweed I have received from still ponds in the interior of New Jersey and from Oyster Bay (Long Island).

Brief and unsatisfactory as these short notes of localities are, yet I am in hopes that they may prove of some use to the amateur when searching for stock for his *Aquarium*, and that they may lead him to find

"Books in the running brooks,
Sermons in stones, and good in everything."



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